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CIVIL ENGINEERING.

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Notes on the U. S. Steamship "Michigan." *By* B. F. Isherwood, *Chief Engineer U. S. N.* (*With a Plate.*)

The "Michigan" is a three-masted fore-topsail schooner-of-war, built in 1843, (I believe,) on the Northern Lakes, for service in those waters. Since that period she has been kept constantly in commission, making some eight years of uninterrupted service, excepting when the winter months compelled her to be laid up in common with other vessels navigating the Lakes. The following information, taken in part from a careful examination of her log book, and the rest from reliable sources, will be of value as a correct contribution to the statistics of steam navigation.

Hull.—Length, 162½ feet between perpendiculars; beam, extreme, 27 feet; depth of hold, 12 feet; deep draft, 8¼ feet; light draft, 6 feet 11 inches; mean draft, 7 feet 7 inches; greatest immersed amidship section at mean draft, 183 square feet; displacement at mean draft, 570 tons. The hull is composed of wrought iron plates, riveted on T shaped iron frames. Thickness of plates, ½ inch, uniform from bottom to top, clinker fastened; size of frames, $4\frac{1}{2} \times 4 \times \frac{5}{8}$ inches; distance from centre to centre of frame, 2 feet. The machinery and coal occupy 60 feet long in the centre of the vessel. Total weight of hull, 507,387 pounds. As the Lakes are composed of fresh water, the objection to iron vessels, of the rapid fouling of their bottoms when employed in sea water, does not apply to the "Michigan."

PADDLE WHEEL—Of the common radial kind. There are 16 sets of paddles, and each set is in four pieces; that is, they are split vertically and horizontally. The pieces vertically are bolted one on each side of the arm, and horizontally, or on the face of the wheel, they are arranged alternately. The paddle surface is then equivalent to sixteen paddles, 7½ feet long and 26 inches broad. Mean immersion of lower edge of paddle, 3 feet 1 inch; diameter of wheel from outside to outside of paddle, 21 feet.

The bunkers stow 120 tons of coal.

ENGINES.—There are two engines, placed side by side at an inclination of 20½° from the keel. They have oak frames, and the air pumps work with a solid piston, at the same inclination as the cylinders. Diameter of cylinders, 36 inches; stroke of piston, 8 feet; diameter of air pump, 29¼ inches; stroke, 31½ inches; diameter of feed pump, 5½ inches; stroke, 31½ inches; condenser capacity, 21 cubic feet; hot well, or reservoir, capacity, 21½ square feet; diameter of outboard delivery pipe, 10½ inches. Cylinder valves are of the double balance puppet kind; the steam valve having its upper disk 9¼, and its lower disk 8¼ inches diameter. The exhaust valve is the same, excepting that the disks change places, the larger being below, and the smaller above. Total weight of engines and frames, 196,000 lbs.; mean cost per pound of engine, 24 cents.

BOILERS.—There are two iron boilers, with single return ascending flues. Total heating surface, 1976 square feet; total fire grate surface, 84 square feet; steam room capacity, 430 cubic feet; fire grates, ¾ inch thick, with ⅝ inch air spaces between. Four furnaces in all; width of each furnace, 44½ inches. Each boiler has four arches below, of the aggregate cross area of 12·75 square feet at the bridge wall, and 10 square feet at the back connexions; and five flues above, 16½ inches in diameter, giving an aggregate cross area of 7424 square feet. It will be observed that the calorimeter is diminished as the chimney is approached nearly 42 per cent., which is rather too great a diminution, as will be perceived from the following considerations: The temperature of the furnace, though it has never been ascertained with any great degree of accuracy, may be taken at about 1000° Fahr., which is certainly below the truth; and supposing the fixed gases, which are the products of combustion, to be delivered into the chimney at a temperature of 400° Fahr., then by the law of Mariotte a fixed gas reduces in bulk $\frac{1}{180}$ for each reduction of 1° Fahr. of temperature; consequently the volume of the gases at the chimney will only be 37 per cent. of what it was at the bridge wall; and did their velocity continue the same, the calorimeter, or area of flue, should diminish in the same proportion. Now, the velocity of the draft is in about the proportion of the temperatures; in order, then, that the products of combustion may pass off freely, the cross area of the flue should be nearly the same throughout. In fact, it will be found that the reduction of the calorimeter at the chimney should not exceed about ⅛th of that at the bridge wall. If it be reduced below this, there will be a choking of the draft, more imperfect combustion of the fuel, and increased deposition of soot. The diameter of the chimney for both boilers was 4¼ feet; area, 14,186 square feet; height above top of boilers, 27 feet.

These boilers had a powerful draft, consuming 18·43 lbs. of bitumin-

ous coal per hour per square foot of grate. The proportion of grate to heating surface was as 1·00 to 23·52. The proportion of calorimeter at the chimney to the grate surface was as 1·00 to 11·31; at the bridge, as 1·00 to 6·59, which latter is about a mean proportion in practice. The consumption of fuel per hour was 1548 lbs.; steam pressure per boiler per gauge, 15·5 lbs.; double strokes of engine per minute, 18½; cut off at ·42 of the stroke from the commencement. It appears from the indicator diagrams that the initial pressure in the cylinder was 2 lbs. less than in the boiler. We have consequently $((18\frac{1}{2}\times 2)\times 7{\cdot}068\times 8{\cdot}\times{\cdot}42\times 2\times 60,)$ 104493·3 cubic feet of steam at a total pressure of (14·7 + 13.5) 28.2 lbs. generated per hour by 1548 lbs. of coal. To this must be added the steam required to fill the spaces between the valves and in the cylinder nozzle at *one* end of the cylinder, 2·2 cubic feet, and the clearance ·4—total, 2·6 cubic feet, and $2{\cdot}6\times(18\frac{1}{2}\times 2)\times 2\times 60 = 11440$. And 104493·3 + 11440 = 115933·3, which, divided by the volume of steam compared to the volume of water, viz: 941, gives 123·2 cubic feet of water evaporated, and taking the weight of a cubic foot of water at 62½ lbs., we have 7700 lbs. of water evaporated per hour by 1548 lbs. of coal, or in round numbers, 5 lbs. of water by 1 lb. of coal. This is certainly a low result, but then the calculation does not include the amount carried over by priming, which must have been considerable from the small proportion of steam room in the boilers. However, it is evident that the proportion of 23·52 square feet of heating to 1·00 of grate surface is not sufficiently large, with so rapid a combustion as 18·43 lbs. of coal per hour per square foot of grate. In the boilers of the "Pacific," on which experiments were tried, (the results of which will be found in the *Journal* of February last, p. 137,) bituminous coal was used, and the mean of twelve different varieties gave an evaporation of 7·19 lbs. of water per hour per pound of coal; burning per square foot of grate per hour 15.04 lbs. of coal. But then the proportion of heating to grate surface was nearly as 30 to 1, while the proportion of the calorimeter to the grate surface was about as 1 to 5·32. Supposing the absorption of heat from the gases to be in the proportion of the heating surface and quantity of coal consumed, it is evident the calorimeter should enlarge in an equal proportion. Now the proportion of heating surface between the boilers of the "Michigan" and the "Pacific" was as 23·52 to 30, or as 1·000 to 1.276, and the proportions of fuel burnt in equal times was as 1·000 to 0·816. Hence the proportional cooling down of the gases would be $\frac{1{\cdot}000}{1{\cdot}000} = 1{\cdot}000$ and $\frac{1{\cdot}276}{0{\cdot}816} = 1{\cdot}563$. To have obtained results somewhat similar to the "Pacific's," the calorimeter of the "Michigan" should have been made in this proportion to the "Pacific's;" that is, $1{\cdot}563\times 5{\cdot}32 = 8{\cdot}315$; that is to say, the proportion of calorimeter to grate surface in the "Michigan" should have been as 1·000 to 8·315; whereas it was at the chimney much less, viz: as 1·000 to 11·31, though more at the bridge, viz: as 1·000 to 6·92. It therefore appears the calorimeter was too small in the "Michigan's" boilers, taking those of the "Pacific" for the standard, which gave considerably better results. Weight of "Michigan's" boilers and chimney, 68,000 lbs.; weight of water in boilers, 50,000 lbs.

PERFORMANCE.—The mean speed of the "Michigan," between September, 1845, and August, 1847, taken from her log, and computing the distances from Mitchell's Map of the Lakes, that being the latest authority, is 10·4 statute miles per hour. Mean revolutions of the wheels per minute, 18½; slip of the centre of reaction of the paddle, 20·1 per cent.; oblique action of the paddle 13·1 per cent.; mean effective pressure on piston by indicator, 18·44 lbs. per square inch; real horses power developed by engines, 333·66.

Loss of Power by the Air Pump.—The power required to work the air pump can be easily computed from the appended indicator diagram, plate 3, taken from it. The pump being a forcing one, the mean pressure taken from the diagram will represent the whole power required to work it. The capacity of the pump is 12·25 cubic feet; that of the cylinder 56·544, and the pump makes one discharging stroke to every two strokes of the cylinder; their capacities will therefore be relatively as 12·25 to 113·088, or as 1·000 to 9·232. The mean pressure upon the pump piston is 6·625 lbs. per square inch; it is therefore equivalent to $\left(\frac{6·625}{9·232}\right)$ 0·718 lbs. on the steam piston, and 0·718 is 3·9 per cent. of 18·44; that is to say, the power required to work the air pump, exclusive of the friction of its piston and journals, is 3·9 per cent. of the total power developed by the engine.

By an inspection of the diagram, it will be observed that the forcing stroke commences at A, and that not until the piston has accomplished three-fourths of its stroke, that is, arrived at B, is there any discharge from the pump; the curved line A B is a hyperbola, and formed by the compression of the vapor and air in the pump. At the point B, a sudden discharge of water and air seems to have taken place, accompanied by as sudden a reduction of the pressure, which, however, rapidly rises till at the point C it is again at a maximum; another discharge then seems to take place, followed by a reduction (though a considerably less one,) as before, and then another rise, not so great as before, and so on. When the delivering stroke is accomplished, and the piston commences its return at D, the outboard delivering valve closes, and the pressure immediately falls to 12½ lbs. below the atmosphere, which is retained until the commencement of the following delivering stroke. By now observing the indicator diagram, taken from the steam cylinder, it will be perceived that the maximum condensation in the cylinder was only 11¼ lbs. below the atmosphere, being less by 1¼ lbs. than in the air pump. At the same time the gauge attached to the condenser showed 27 inches, or 13½ lbs. below the atmosphere. The gauge must therefore have been inserted near the jet, and shows how little reliable are its indications unless it be attached to the proper part of the condenser; for it is wholly impossible that the condensation can be better in the condenser than in the pump, and yet the gauge here shows it to be 1 lb. better; and from the high professional character of the engineer who took the diagrams, I am persuaded his gauges and indicator were in good order and accurately adjusted.

The height from the bottom of the air pump piston, at the termination of the delivering stroke, to the mean level of the water outside the vessel,

is 4½ feet; this column would balance a pressure of 2 lbs., consequently the delivery valve should have raised, had there been no other resistances, when the indicator showed a pressure of 2 lbs. above the atmosphere; but the diagram shows it did not raise until the pressure amounted to 10 lbs. above the atmosphere. Where did this additional resistance, equal to 8 lbs., come from? Clearly from friction of the water on the sides of the pump, reservoir, and delivery pipe; from the weight of the delivery valve, and from the contractions of the delivery pipe and consequent high speed at which the water had to be forced through it, together with the consequent greatly increased friction, for the friction and resistance increase as the square of the velocity. There was also a very strong back pressure of vapor from the reservoir, owing to the small size of the delivery valve.

The area of the pump was 671·95 square inches; of the delivery pipe only 86·59 square inches, or the pump area was 7·76 times that of the pipe. The capacity of the reservoir was 21½ cubic feet; that of the pump 12¼ cubic feet, or the reservoir was 1·755 times larger than the pump. The reservoir had no standing or air discharge pipe, and the delivery pipe let out at the centre of its height. Now, at each stroke of the pump there was discharged one-fourth of its capacity into the reservoir, and had the reservoir been free of water, there would have been but little resistance from the compression of the air within it; the capacity of the reservoir comparatively with the bulk of water thrown into it per minute being about seven times greater. But the reservoir was situated almost wholly below the level of the outside water at mean draught, there being only about 4 cubic feet of space in the top above the outside water level, or only one-fourth more than the bulk of water discharged into it, and this bulk was discharged into it during the short time the piston was performing one-fourth of a stroke, or in $\frac{4}{10}$ths of a second. The outlet area being 7·76 times less than the inlet area, could give but little relief during $\frac{4}{10}$ths of a second. We consequently see the back pressure on the delivery valve rising 8 lbs. above what it should be, principally from the compression of the air in the top of the reservoir. This increased back pressure is a total loss, for the closing of the delivery valve on the return stroke shuts it off, and prevents it from giving back by its expansion, the power expended on its compression. For the want, then, of a standing pipe, or extension of the reservoir above the water level on the outside, and open to the air inside the vessel, and to the want of an outboard delivery pipe of a sufficiently large area, we perceive that a considerable unnecessary expenditure of power has to be made by the engine in working the air pump. Practical data is only valuable when we reason upon it and ascertain its results; in that case failures are nearly as valuable as successful experiments; otherwise bad and good are confounded; and it is impossible to predicate of any essay, whether it will be as good, better, or worse than its predecessors.

The diagram, taken from the steam cylinder, which I have added, was not taken at the mean point of cutting off, but was taken with the mean pressure of steam in the boiler per gauge, viz: 15·5 lbs. per square inch—cutting off at one-fourth the stroke. Mean effective pressure, 14·4 lbs. per square inch; double strokes per minute, 18; vacuum in con-

denser per gauge, 27 inches. When this diagram was taken, the vessel was very light.

The cut-off used was Sickle's arrangement, as originally patented; that is, the valve was tripped from the lifting rod. The diagram shows the steam valve to have had no lead; the exhaust valve did not open until the steam stroke was entirely performed, and it seated before the exhaust stroke was completed, *cushioning* the steam at A.

The space between the valves and in the cylinder nozzle added to the clearance make 2·6 cubic feet to be filled with steam before each stroke can be commenced: this steam is not entirely lost when the engine works expansively;—it would be entirely lost did the steam *follow* for the full stroke; and this loss will become less and less in proportion as the steam is worked more and more expansively. In the present case of the "Michigan," 2·6 cubic feet is equivalent to 0·368 foot on the length of the cylinder. The mean effective pressure in the cylinder for the whole stroke of 8 feet being 18·44 lbs. per square inch; the total power developed by the engine can be represented by $18{\cdot}44 \times 8 = 147{\cdot}52$. The effective pressure at the end of the stroke (at which pressure the exhaustion takes place) is 8·5 lbs.; consequently the power lost by filling the vacuities before the stroke commences, can be represented proportionally by $8{\cdot}5 \times 0{\cdot}368 = 3{\cdot}128$, and 3·128 is 2·12 per cent. of the total power, 147·52; therefore, 2·12 per cent. of the total power developed by the engine has been thus lost.

Indicator Diagram from the Steam Cylinder.—Steam pressure in boiler per gauge, 15·5 lbs. per square inch. Vacuum in condenser per gauge, 27 inches. Strokes of piston per minute, 36. Vessel very light. Mean effective pressure 14·4 lbs. per square inch. Area of valve opening 121·66 square inches. Capacity of cylinder, 56·544 cubic feet.

Indicator Diagram from Air Pump.—Temperature in air pump, 100° Fahr. Mean effective pressure, 6·625 lbs. per square inch. Capacity of air pump, 12¼ cubic feet. Capacity of condenser, 21 cubic feet.

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*Railway Traffic.**

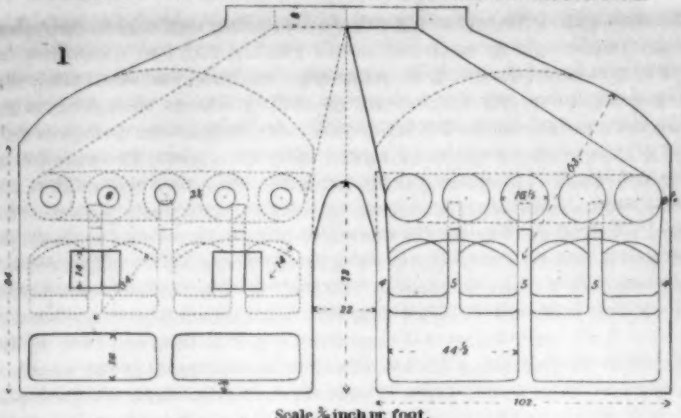
The railway traffic for the past year presents a gratifying result—we mean as to the increased amount of it. Increased profits are another matter, dependent in a principal degree on the capital accounts remaining stationary, or nearly so, which unhappily has not by any means been the case. Well, the traffic of 1850 has exceeded that of the former year by no less a sum than 1,741,418*l.* The traffic of the past year (1850) reached the figure of 13,142,235*l.*, and is derived from 6733 miles of railway, including those comparatively few Companies, old and new, who do not publish their returns in the regular way, but who cannot nevertheless evade a knowledge of the true amount of their traffic, or a very near approximation to it. This gives an average receipt per mile per annum of 1944*l.*

But if we confine ourselves to the amount of traffic as furnished by the publishing or above-board Companies, rejecting that of those who withhold their traffic returns, we find the receipt per mile per annum ranging higher, simply because it is only the very inferior lines which avoid publication; the lines with very mean traffics. The average then rises to 2227*l.* per

* From the London Railway Journal, No. 605.

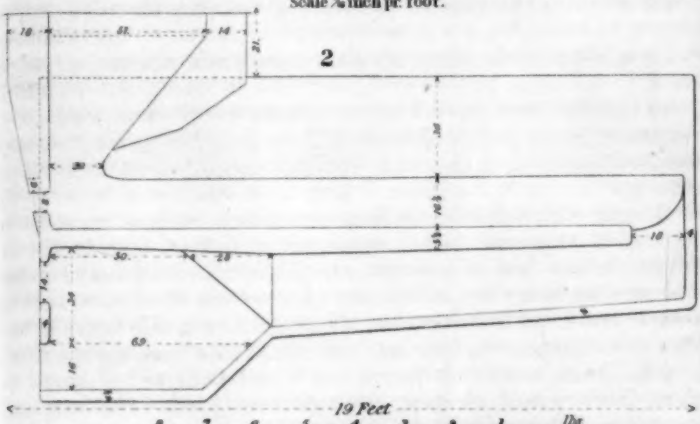
BOILERS & DIAGRAMS OF THE U.S. STEAMSHIP MICHIGAN.

1



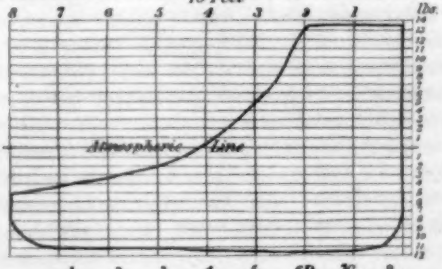
Scale ¾ inch pr. foot.

2



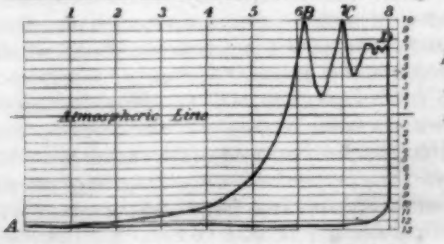
19 Feet

3

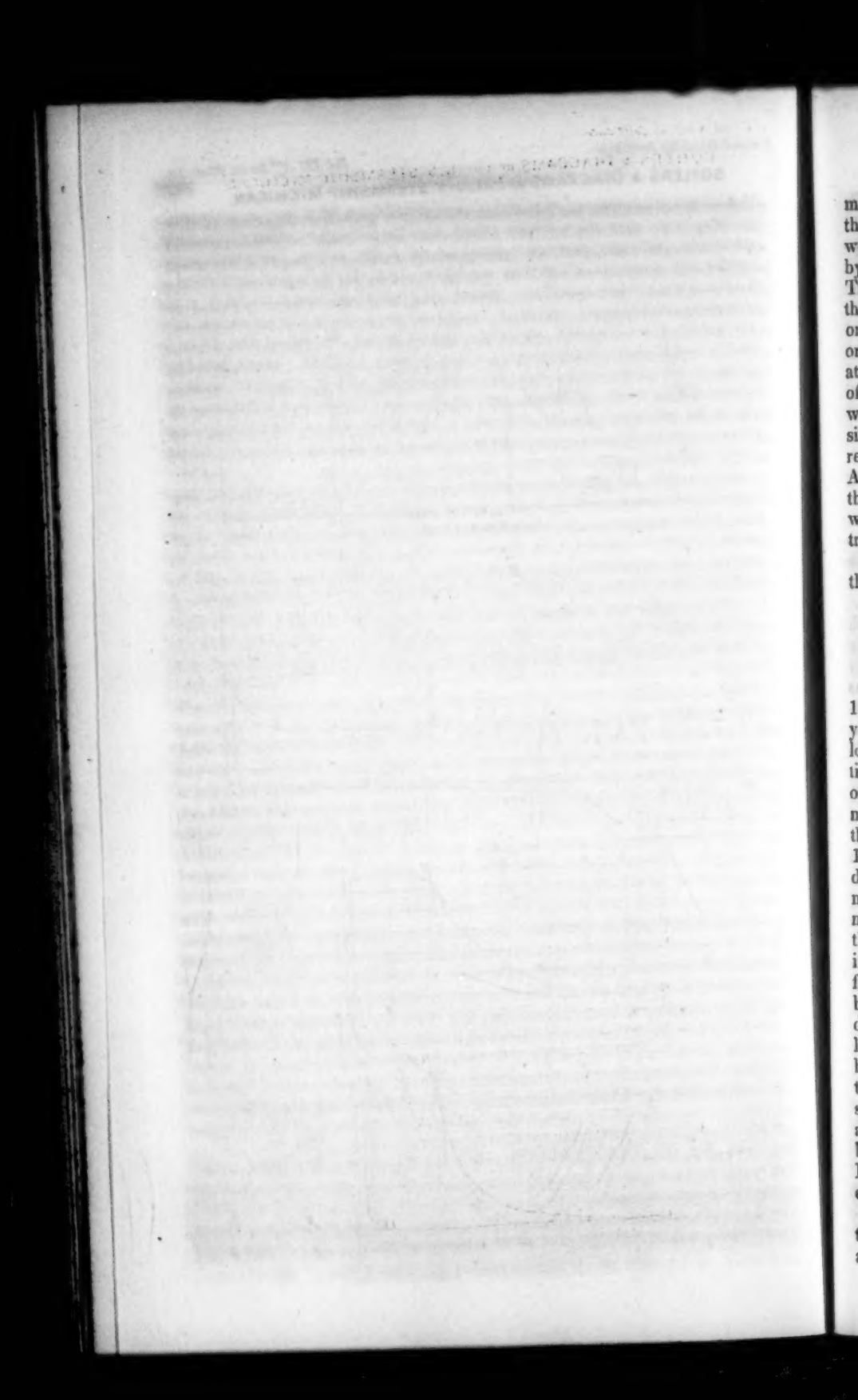


Indicator Diagram Steam Cylinder

4



Indicator Diagram Air Pump



mile per annum. The traffic of the publishing Companies amounts, during the last year, to 12,755,235*l.*; the miles open at the end of the year were 6257. But we must not, of course, divide the receipt of 12,755,235*l.* by the miles then open (6257) to get at the receipts per mile per week. That would be very fallacious. For the 6257 miles were not open during the whole of the year. On the contrary, at the beginning of the year, only 5256 miles were open, or about 1000 miles less. The mileage went on increasing week after week, and month after month, until it reached, at the end of the year (in respect to the publishing Companies) the extent of 6257 miles. We get at the year's average per mile by adding up the week's averages per mile, a method by which truth, as near as it is possible to reach it, is arrived at. We may then say that the average mileage receipt per annum of all the publishing Companies was, for 1850, 2227*l.* And it is useful to make this separation of the publishing Companies from the hole-and-corner ones for the sake of comparison with past years, for which we could not possibly make any estimate of the secret Companies' traffic.

In comparison with former years the traffic per mile per annum stands thus:

For 1842 it was	£3118,	For 1847 it was	£2870,
" 1843 "	3085,	" 1848 "	2556,
" 1844 "	3278,	" 1849 "	2302,
" 1845 "	3469,	" 1850 "	2227.
" 1846 "	3305,		

Observe how the traffic increased per mile from the year 1842 until 1845, when it reached its maximum. And then from 1845 to the last year, how it sank down, like the mercury in bad weather, to the very lowest point it has yet reached, viz., 2227*l.* But it is satisfactory to notice that the difference between the last year's traffic and that of the former ones is much less, notwithstanding that we have had a greater number of miles opened in 1850 than in any one of the former years. For, during the year 1843 there were 56 miles opened; during 1844, there were 194 miles opened; during 1845, there were 263 miles opened; during 1846, 593 miles; during 1847, 839 miles; during 1848, 975 miles; during 1849, 835 miles; and during 1850, more than 1000 miles. We must, however, here remark that, although there were for the purposes of this table more than 1000 miles opened during the past year (1850,) yet, in point of fact, only 591 were opened during that year. The additional four or five hundred miles were in reality opened during former years, but in pursuance of that narrow-minded policy which demeans a good deal of railway management, the Companies opening those four or five hundred miles did not immediately publish the traffic returns of them, because forsooth, they (the directors) wished to have a short time to themselves for the traffic to develope itself; fearing that the "public" should be "alarmed" by what they called a "premature" publication, albeit the public, that is, the Shareholders, took much greater alarm by being kept in the dark, and did not at all relish the circumstance of the Directorates keeping the information as to how the traffic was getting on, entirely to themselves.

There is now every probability of the mileage traffic not only ceasing to decrease, but to begin again to take an upward tendency. But really and truly, it depends much upon whether the Directors and Shareholders

will be prudent. If they resolve to make for the present as few more miles as possible, then we cannot doubt that the mileage receipts would soon tend upwards, and, as a consequence, the dividends increase. Suppose for the sake of argument, that the mileage now stopped at what it is, and the capital accounts were closed, does any one think the traffic per mile would not go on increasing? So extremely sudden and decisive a step we know will not be taken. The lines three-parts finished must be completed. The present mileage must be further increased to some extent. In that there is no danger. The danger is, that Directors and Shareholders will not be true to their own interests; or that Directors will go mad again, and Shareholders renew their foolish and almost criminal state of indifference; that between them they will rush again into the wildest speculation, or not now close up as quickly as they can. If Directors will do their duty, which we think we are fully warranted in saying they certainly will not, unless the Shareholders look well after them, there is little fear that in course of time railway matters will be righted. The traffic of this year is expected to do something material in rectification of them.

The 6733 miles, including those "little goes" who sink into the back ground, and do all they can to avoid publication, have cost the enormous sum of 230,522,731*l.*, being at the rate of 34,238*l.* per mile.

The closing of the capital accounts, that is the great object at which the Shareholders should strive; and yet it is the very one which we were jeered at for being the first to moot. We wanted the capital accounts for the old lines closed at once, and those for the new closed as soon as possible. For, just see how the keeping of them open works. Shareholders have vainly flattered themselves with the belief that the new and cheaper railways were bringing down their average mileage cost. No such thing. Instead of that, the average mileage cost has been going up. In 1842 the cost per mile was 34,690*l.*; in 1843, 36,360*l.*; in 1844, 35,670*l.*; in 1845, 35,070*l.*; in 1846, 31,860*l.*; in 1847, 31,709*l.*; in 1848, 34,234*l.*; in 1849, 35,214*l.*; and in 1850, 35,229*l.* So that notwithstanding all the new and cheaper lines, it is actually now higher than in 1842. And it will go on increasing if Shareholders do not go on supervising. The "IMPROVEMENTS" of the lines will never cease as long as Shareholders are simple enough to pay for them, or subscribe large sums of money without knowing to what they are applied.

With good management there is great hope, and trusting that means will be taken to obtain it where it is wanting, and keep it where it is found—and determined to do our part towards railways—we think we might wish our readers a happy new year.

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*New Method of Preventing Incrustations in Steam-Boilers.**

Mode of preparation, by M. Saillard, of Nantes:—Catechu, 100 lbs.; subcarbonate of potash, 50 lbs.; subcarbonate of soda, 50 lbs.; common resin, 10 lbs.; lime, 20 lbs.; water, 300 lbs.—1. Boil for 20 minutes the subcarbonate of potash and soda with the lime and resin, with 200 parts of water; remove the fire, allow the mixture to settle, and draw off the clear liquor.—2. In another boiler, make a decoction of the catechu, in

* From the London Mining Journal, No. 802.

the remainder of the water; after boiling for 10 minutes, pass the decoction through a fine hair or silk sieve, and add to it the liquor obtained in the previous process; stir the mixture, and keep it in well-stoppered vessels. Mode of application:—The boiler having been well cleaned, introduce through the man-hole, as soon as the boiler is half-filled with water, a ¼ lb. of the resinous double subcarbonate of soda and potash per horse-power every six weeks. The quantity above-mentioned should be introduced every six weeks, by means of the feed pipes, when the steam is low. For marine boilers, introduce 3 lbs. of the preparation every four hours into the boiler for every 100 horse-power, and blow off once in every eight hours. The blowing off should be performed 10 minutes previous to the introduction of the preparation into the boiler.

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*Increase of Railway Traffic.**

We have usually considered that the traffic of the country increases annually about 10 per cent., so that in the course of ten years the traffic would be doubled. Of course this must have a limit. Increase at this rate could not go on for ever. Thus it appears from the following 18 lines, on which there has either been no increase of mileage or a very trifling one, that the old lines have a less increase than the new, and the older they are, generally speaking, the less the *pro rata* increase.

	Increase per cent. on the traffic of the year 1849, during the year 1850.
Midland,	2¾
Brighton,	5¾
Caledonian,	6½
Newcastle and Carlisle,	8½
South Western,	9
Bristol and Exeter,	10½
York, Newcastle, and Berwick,	11¼
Ulster,	14
Belfast and Ballymena,	19¼
Great Southern and Western,	20
South Devon,	21
South Eastern,	23¼
York and North Midland,	25
Lancaster and Carlisle,	28½
Shropshire Union,	30
Leeds and Thirsk,	45½
Chester and Holyhead,	64½
Eastern Counties (decrease)	— 4¼
Mean 19 per cent.	341¼

The mean annual increase, it will appear, is at the rate of 19 per cent., or nearly double our estimate. But the past has been a rather extraordinary year. Traffic has increased much more rapidly than for years before, so that the year 1850 does not, therefore, present a fair measure of the average increase of traffic. Neither is it likely that the present year will. We might this year have a rise in the passenger traffic of possibly 50 per cent. or more over the past. Excluding these anomalous years, we do not think we shall err much in fixing 10 per cent. or about the half of the past year's increase as a fair annual average. If no more

* From the London Railway Journal, No. 605.

1845 follies are therefore committed, railways will shortly come round to a fitting state of prosperity.

One or two special observations on this table may not be amiss. Generally speaking, it will be observed that the old lines present a less per cent. increase than the new ones, arising from the well-known fact, that the traffic of railways, like many other works of the creation, require time for development. Full traffic does not come on a railway as soon as it is made, though it lie between towns whose traffic has no perceptible increase. It takes time to turn traffic out of its old channels. People are naturally averse to sever old connexions, and adopt new ones and new courses all at once. They must be coaxed and brought to them gradually.

On the Midland, it will be noticed, that there has been the least increase, and, on the Eastern Counties, a decrease of 4¼ per cent. Both of these lines are exposed to a competition with the Great Northern, which is no doubt a reason for the falling off; but whether it explains the whole of it, we do not pretend to say. On the Midland, the goods have very much increased, for which the line is well situated, provided the Directors and the Directors of the Great Northern, will but work comfortably together. Had it not been for the increase in the goods department, the falling off would have been great. The Eastern Counties ought to have been a part of the Great Northern between Cambridge and London, as we always contended. The saving of capital would have been great to the latter Company, and the traffic, at however small a rate carried, would have been a god-send to the former, while the line would have retained a good part of the traffic it then had, as its own proper traffic.

It was a great mistake in both Companies to have two lines so near and parallel, which we did all in our power at the time, publicly and privately, to prevent. Both directions, however, were occasionally mad, or when the one had any reason the other had not.

The Leeds and Thirsk, and the Chester and Holyhead, in their per cent. increase have distanced all the others, and almost jumped out of the class. They are both new lines, and had both great room for that increase, which we are glad to find they have realized.

While there is good reason for gratulation in the increases which the above table exhibits, we cannot help feeling regret at some of the facts disclosed.

It there appears that the average cost per mile has increased from 31,860*l.* on 2610 miles opened in 1846, to 35,229*l.* on 6238 miles opened in 1850, at the same time that the traffic has decreased from 3305*l.* per mile at the former period, to 2227*l.* at the latter. In other words, the cost per mile has increased 11 per cent., and the traffic has decreased 33⅓ per cent., or three times as fast.

This is by no means an encouraging feature, yet it is to be hoped, the gradual increase of traffic will presently make all right. To accomplish so desirable an object, however, it will require the greatest vigilance and honesty of purpose on the part of railway boards.

Another feature must not be overlooked in this mileage decrease of traffic, namely, that passengers and goods are both carried at less tariffs than they were, with, it is true, a less expense, but not a proportionally

less. The consequence is, that the profits must decrease faster than the traffics have. Hence, one reason why the dividends have so much sunk.

Several reflections might be made on these less favorable features; but we are not disposed to indulge in them, or to damp the joyous feeling that all must experience, in the decisive proofs of the growing traffic of the country. All that we want to do, is to impress on Directors the necessity of caution in future extensions, and upon Shareholders to be careful how they encourage or sanction them. There is evidently a vitality in the railway system, which will, if not crushed with new and profitless burthens, grow out of all the difficulties with which, by the folly of Directors and—it must not be concealed—the rapacity of Shareholders, it has been pressed down and encumbered.

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*Statistics of Railways.**

By a work recently published, it appears that there were in operation, at the commencement of 1849, in different parts of the globe, a total length of 18,656 miles of railway, on which a capital of 368,567,000*l.* had been actually expended. Besides this, it is estimated that there were, at the same epoch, in progress of construction, a further extent of 7829 miles, the cost of which, when completed, would be 146,750,000*l.* Thus when these latter lines shall have been brought into operation, the population of Europe and the United States (for it is there only that railways have made any progress) will have completed, within the period of less than a quarter of a century, 26,485 miles of railway; that is to say, a greater length than would completely surround the globe, at a cost of above 500,000,000*l.* sterling. To accomplish this stupendous work, human industry must have appropriated, out of its annual savings, 20,000,000*l.* for twenty-five successive years.

Statistics of Steam Power in France.†

There are 5607 manufactories in which steam machinery is employed. Of boilers, the number is 9288, of which 8776 were made in French establishments. These boilers represent a force of 65,120 horses' power, calculating the horse power as 75 kilogrammes (180 lb.) raised one metre (1 yard) per second. They represent the available force of 195,361 draft horses and 1,367,530 laborers. The number of boilers employed in the preceding year was only 8023, and only 4033 establishments existed in which steam power was used. The length of railway now open for traffic is 2171 kilometres (1300 miles), on which are employed 725 locomotives. The number of steam trading vessels is 279,—tonnage, 40,098 tons. They are propelled by 502 engines, constituting a total power of 22,893 horses. The merchandise transported by these vessels amounted to 780,948 tons. The progress of steam navigation in France is thus indicated: In 1835 there were 75 steamers, by which 1,038,916 passengers were carried, and 88,140 tons of merchandise; last year there were 279 steamers, 2,808,886 passengers, and 730,948 tons.—*Journal des Debats.*

* From the London Builder, No. 414. † Ibid.

*A Novelty in Railway Management.**

This is a principle which we have long since advocated in the *Artizan*. It will be remembered that, in Mr. Leclaire's factory, in Paris, all the men have a share in the profits of the business.

The dividend declared by the London and Brighton and South Coast Railway Company, at a meeting of the proprietors held on the 24th, was £2 12*s*. per cent. for the half year, leaving a surplus balance of profits of £4248. The total receipts for the half year have been £306,219, being an increase of £19,862 over the corresponding period of 1849. The total increase of income has been at the rate of 17¾ per cent. during the last three years, whereas the expenditure has been 12¾, occasioned by the amount of renewals.

Two important features are shown in the present report. It is intended that the principal officers of the company, upon whose exertions its prosperity in a great measure depends, shall benefit by the increase of dividend in each year, so that for an advance of 1 per cent. of dividend, they shall receive an advance of 25 per cent. on their salaries. As regards the other servants of the company, it is intended to provide a retiring pension in the event of their being disabled or superannuated in the company's service; £1000 annually will be appropriated towards a benevolent fund for this purpose.

The Ventilation of Collieries, Theoretically and Practically Considered.

By Mr. William Price Struve, *M. Inst. C. E.*†

The author commenced by showing that the general principles which ought to govern the ventilation of collieries were—1, That a current of air through the channels of collieries, at a velocity of five feet per second, was sufficient for most purposes. 2, That a current exceeding that velocity would only be attained at the expense of leakage and other evils. 3, That, in order to obtain the requisite supply of fresh air, the channels of a colliery or mine ought to be enlarged, according to the exigency. In the process of laying out a mine, a sub-division occurred by which the workings were apportioned into numerous compartments, which facilitated the system of splitting the current of air, or diverting it into numerous channels, giving to each compartment a separate and, therefore, more effective ventilating force; at the same time the area of the channel was enlarged, and the aggregate length of the air-tube shortened, so that it was quite practicable to pass through the workings of a mine three hundred cubic feet of air per minute for each man employed. A comparison of the dimensions of the air passages and the velocities of the currents in numerous collieries led to an estimate of motive power required to produce the results attained in the best ventilated mines, in case of the employment of a steam engine and air pumps. This power would have varied between 23 horse power and 26 horse

* From the London Artizan, for February, 1851.

† From the London Railway Journal, No. 599.

power. The efficiency of furnace ventilation was always increased by the depth of the shafts, especially if they were entirely devoted to the purposes of ventilation, irrespective of the working of the pit. The experiments of Mr. N. Wood, Mr. G. Elliot, Mr. H. Vivian, and other mining engineers, were then quoted, to demonstrate the insufficiency of the "steam jet" as a means of promoting ventilation, showing that it was a most wasteful application of power, when compared with the steam force employed to work Struvé's mine ventilator at the Eaglesbush Colliery. This apparatus consisted of two hollow pistons, resembling large gasometers, plunging into cisterns of water, and having inlet and outlet valves. The pistons received alternate motion from a small steam engine of 5 horse power, and being filled and emptied at each revolution of the crank, produced a regularity of current and a degree of copious ventilation hitherto unknown in the mines to which they had been applied. The small cost of their establishment—only about one hundred pounds for an extensive mine—joined with the little liability to getting out of order, was much in their favor. The paper terminated with copious extracts from the able mining reports of Mr. John Phillips and Mr. Kenyon Blackwell, confirming all the positions assumed by the author. The discussion upon this paper was announced to take place at the next meeting, Tuesday, November 26, until which time the meeting was adjourned.—*Proc. Inst. Civ. Eng., Nov.* 19, 1850.

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*Cornish Engines.**

The number of pumping engines reported this month is 27. They have consumed 2081 tons of coal, and lifted 19,000,000 tons of water 10 fathoms high. The average duty of the whole is, therefore, 52,000,000 pounds, lifted one foot high by the consumption of 94 lbs. of coal.—*Lean's Engine Reporter, Jan.* 8, 1851.

Messrs. Clark and Motley's Patent Locomotive Steam Carriage for Common Roads.†

These gentlemen have put forth a prospectus, in which they show that the capital cost of a steam locomotive carriage for the common roads is 600*l.*, and that the produce from 30 passengers per day, at 1d. per mile, would be 12*l.* 10s., and that the working expenses, including 5 per cent. interest on the capital, would amount to 3*l.* 5*s.* 6*d.* per day, leaving the large profit of 9*l.* 4*s.* 6*d.* per day. But we arrive at quite a different conclusion, and that we do without disturbing the working expenses, and the number of passengers carried. For we say that the passengers who would travel by such a vehicle, would be of the same class as those who travel by railway, the common road steam carriage being, in fact, in competition with the railway system. Very well. What do railway passengers produce as an average? Why, the average is under 2*s.* 6*d.* each. Therefore,

*From the London Railway Journal, No. 608. † Ibid. No. 607.

if the common road steam carriage only took 30 passengers a day, as Messrs. Clark and Motley calculate, the receipts would, at railway fare, amount to under 4*l.* a day; but as the railway fare averages nearly 2*d.* a mile, and Messrs. Clark and Motley mean to carry at 1*d.* a mile, their receipts would be only about 2*l.* a day, instead of 12*l.* 10*s.*, leaving a formidable deficit instead of a lumping surplus on the working of a day's journey. The expenses would be (including the 5 per cent. interest, which amounts, however, to only 1*s.* 8*d.*) 3*l.* 5*s.* 6*d.* per day; the receipts say 2*l*; loss 1*l.* 5*s.* 6d.

Now this is the result, taking their own figures both in regard to expenses, and carrying 30 passengers a day.

If they want to show a surplus, they must alter the number of passengers they will carry; for it is not reasonable to expect their passengers will produce more than railway passengers.

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*Plate-Iron Girder Bridges.**

The annexed engravings show the construction of one of the numerous bridges which have been designed by Mr. Martin, the engineer, to carry the railway from the London and North-Western Railway to the East and West India Docks. It carries the railway over Randolph street, Camden Town.

FIG. 1.

TRANSVERSE SECTION.

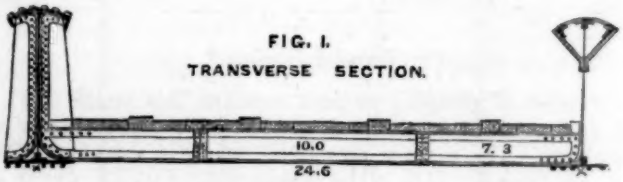
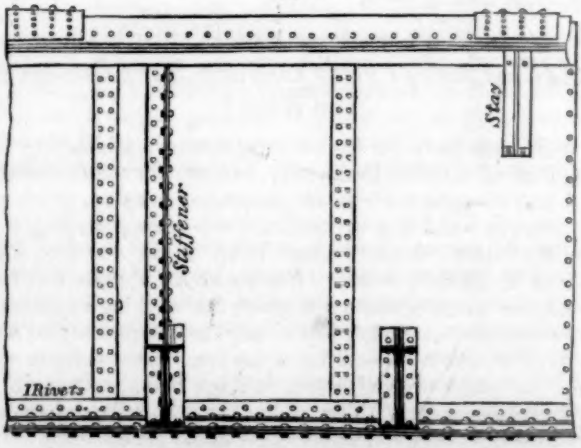


Fig. 2.



The peculiarity consists in constructing the bridge with two side girders, each of a single web, of plates of iron, 71 feet long, 6 feet 7½ inches high,

* From the London Architect, for November, 1850.

and $\frac{5}{11}$-in. thick; put together with plates 5 inches wide, overlapping the vertical joints, and $\frac{3}{4}$-inch rivets placed 3 inches apart, and fixed to the top and bottom plates by angle iron 3 inches wide, and $\frac{3}{4}$-inch rivets. The bottom plate is 2 feet 8 inches wide, made with $\frac{5}{16}$-inch plates in lengths of 8 feet each, with plates overlapping the joints 6 inches wide. The outer flanch is curved down 1 inch, to throw off the wet; the top plate is 2 feet 8 inches girt, made with $\frac{5}{16}$-in. plates, excepting the three middle plates, which are $\frac{3}{8}$-inch in thickness; the top is curved down 5 inches, and put together with inch rivets. The girders are stiffened by eight vertical plates on each side of the web, of $\frac{4}{16}$-in. iron, fixed by angle iron 3 inches wide, and $\frac{3}{4}$-in. rivets placed 4 inches apart. There are also two similar stiffeners at each end, of $\frac{3}{8}$-in. iron. The top plate is further stiffened by stays of T-iron, $5\frac{1}{2}$ inches wide between each pair of stiffeners.

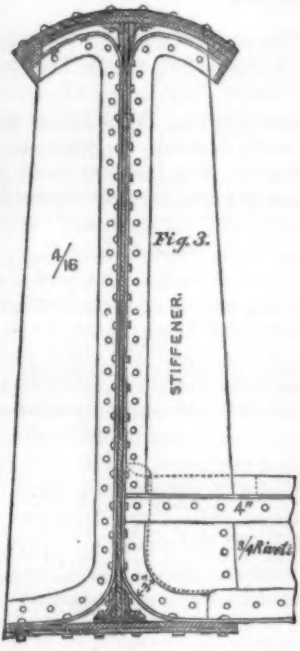


Fig. 3.

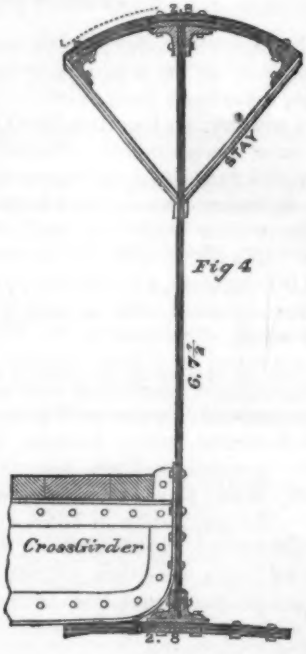


Fig. 4.

The cross girders are 24 feet 6 inches long, and 1 foot 4 inches high, made with $\frac{3}{8}$-inch plates in three lengths, and stiffened by angle iron top and bottom, and on each side, $3\frac{1}{2}$ inches wide, and fastened with $\frac{3}{4}$-inch rivets 4 inches apart. The ends of these cross girders rest upon the two girders first described.

Fig. 1 is a cross section of the bridge. Fig. 2 is a side view of part of one of the longitudinal girders. Fig. 3 is an enlarged section of one of the girders, showing the stiffeners. Fig. 4 is a section through the same girder, showing the stays to stiffen the top plate.

*East Indian Railway.**

The operations of the Bengal Railway Company have been much impeded by the delay of Government in providing the necessary legislative authority to take the ground for the line. The electric telegraph is progressing rapidly, and the entire line will be laid down as far as Diamond Harbour by Christmas. The progress of laying down the wires (which are covered with resin, and protected by earthenware pipes) is at the rate of about three miles a day.—*Indian Correspondent of The Times.*

Public Works at Algeria.†

In the report from the Minister of War to the Legislative Assembly, in the spring of 1850, it is stated that, subsequently to the occupation of Algeria, there have been executed in that colony, at the expense of the mother country, no less than 3270 miles of road; 18,959 acres of marsh lands have been drained; 278,000 yards linear of irrigation channels; and 82,057 yards of main drains or ditches; and 127,000 yards of aqueducts or water courses have been constructed; 91,900 yards linear of street have been formed or regularized in the divers towns; and nearly 32,000 yards linear of sewers formed in them; barracks have been erected for 40,000 soldiers, and hospitals for 5000 invalids. The port of Algiers has been improved, and important works begun at several other points on the coast. Churches for the Christian population, mosques for the indigenous races, have been restored, and new ones built where needed.

The country in which these works have been executed is only 77,120,000 acres superficial (France itself being 131,966,525 acres nearly,) including the Little Desert, which occupies above two-thirds of the surface. The densely peopled portions, are the civil territories of the Prefectures of Algiers, Oran, and Constantine, whose total surfaces are only 706,902 acres. The population in 1848, consisted of 64,123 Frenchmen, 55,141 other Europeans, mostly Maltese, Spaniards, and Sicilians. The different sexes and ages are—men, 49,839; women, 34,937; children, 34,488. The indigenous population is supposed to be three millions; and the army of occupation 60,000 men.

Wrought Iron Beams for Steam Engines.‡

The beams of steam engines, as most persons are aware, have hitherto been made of cast iron, which is liable to break. The attempt to make them of malleable iron, was never dreamt of; and when we state that rolled beams are now to be seen at the depot of the York, Newcastle, and

*From the London Railway Journal, No. 606.
†From the London Architect, for November, 1850.
‡From the London Mining Journal, Nō. 798.

Berwick Railway, the announcement will be received in many quarters with surprise, if not incredulity. We saw the monster plates, however, with our own eyes (the largest plates ever yet rolled,) measuring 17 feet in length, 4 feet 8 inches in breadth at the widest part, and 1⅛ inch in thickness. Each plate weighs upwards of 1 ton 4 cwts. These plates were manufactured at the Derwent Iron works, Consett, and are on their way to Messrs. Tod and Macgregor's works in Glasgow, to form part of a large marine engine: they are much lighter, and, consequently, less cumbrous, than the ordinary cast iron beams, and infinitely safer.

AMERICAN PATENTS.

List of American Patents which issued from February 18, *to March* 11, 1851, *(inclusive,) with Exemplifications by* CHARLES M. KELLER, *late Chief Examiner of Patents in the U. S. Patent Office.*

13. For an *Insulated Fusible Plug for Steam Boilers*, E. H. Ashcroft, Boston, Massachusetts, February 18.

Claim.—"What I claim as my invention, is the arrangement herein described, for surrounding a fusible plug and its case, by a stratum of air, in such manner that the plug shall promptly melt and give warning, after the water gets low in the boiler, but before the boiler plate, to which the apparatus is applied, is left bare of water, substantially as herein set forth.

"I also claim the arrangement of the stopper and plug case, substantially as herein described, for stopping the escape of steam, to admit of the replacement of the fusible plug, without blowing off the steam or water from the boiler, after the plug has melted, substantially as herein set forth.

"I likewise claim the method of preventing the waste of the metal of the plug, after it has melted, by supporting it in a closed socket, the lower unoccupied part of which is of sufficient capacity to receive and retain the metal when melted, and to allow the steam to pass over it to escape."

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14. For an *Improved Annular Steam Boiler;* Thomas Champion, Philadelphia, Pennsylvania, February 18.

"The nature of one of my inventions consists in closing the annular water spaces of my concentric boiler, by means of metallic tapered rings, by which the ends of the cylinders, of uniform length, can be closed even and fair at both ends, so as to stand the fire, and leave only the required space for fire, and so that the constructor can get the rivets in on one side, and at the same time have room for riveting them on the outside.

"Another of my inventions and improvements consists in connecting the lower parts of the annular water spaces, each to each firmly, the upper and inner to the lower and outer one, answering the four-fold purpose of bracing the boiler below, or, if needed, at the sides, giving free ebullition, further assisting evaporation, and giving an opportunity for the dirt to settle in the blow-pipe, whence it may be blown out."

Claim.—"Having thus described the nature of my invention and improvement in the construction of steam boilers, what I claim as new and of my invention, is, 1st, The employment of the tapered rings B, for closing the ends of any of the water spaces of the concentric boilers, in the manner set forth.

"2d, I also claim connecting the lower parts of the annular water spaces, each to each, from the upper and inner to the lower and outer one, substantially as described, by metallic rings or collars, thus giving free ebullition, assisting evaporation, and allowing the dirt to settle down into the blow-pipe, from whence it may be blown out; the aforesaid rings or collars bracing the boiler, as well as forming the connexion between the cylinders."

15. For *Improvements in Hand Looms;* Isaac H. Garretson, Clay, Iowa, February 18.

"My invention consists, 1st, in effecting the movement of the heddles by a motion derived from the lay, through the intervention of a cam, shaft and treddles, or their equivalents, the first of which is made to revolve by means of a ratchet, which is put in motion by the lay, and acts upon ratchet teeth, secured to the cam shafts;—and, second, in effecting the throwing of the shuttle by a motion derived from the lay, by means of a pair of levers, whose arms are connected with the breast-beam and shuttle drivers."

Claim.—"What I claim as my invention, is the device consisting substantially of the tappet shaft, with its ring block, and together with the connecting cord, weight, and marches, whereby the heddles are raised and depressed in the proper order, to form the shed, by the movement of the lay, substantially as herein set forth.

"I likewise claim the device, consisting substantially of the levers, with the breast-beam, cords, and picker-stick cords, whereby the picker-sticks are moved to drive the shuttle, by the movement of the lay."

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16. For *Improvements in Machines for Turning Irregular Forms;* Philo S. Beers, Hamden, Connecticut, February 18.

"The nature of this invention consists in such a combination and arrangement of various mechanical devices in one machine, that a piece of rough timber, of convenient size, being adjusted therein, and subjected to the action thereof, is quickly reduced to the complete form of a carriage wheel spoke, (or such similar article as may be required,) and that without any lateral or longitudinal motion of either the cutters or of the rough material."

Claim.—"What I claim as my invention, are, 1st, the three cutter cylinders, (with cutters arranged as within described,) in combination with the sliding frame, compound cams, and cam-rails, constructed and arranged substantially in the manner and for the purpose herein described.

"2d, I claim the combination of the compound cams and cam-rails, with the sliding frame and devices (within described) for holding and revolving the timber material, whereby such vertical motion is produced in the latter, while being subjected to the action of revolving or vibrating cutters, as to reduce the timber to the required form."

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17. For *Improvements in Tools for Tonguing, Jointing, and Rebating;* John A. Fry, Edinburg, Pennsylvania, February 18.

"The purposes of my invention are to make a tool, by the use of which the workman may make tongues of different thicknesses, the same tool being capable of both tonguing and jointing the stuff, and to make the same tool answer the purpose of a rebating plane. The tool might be called a combined jointing, tonguing and rebating plane. The advantage of such a tool is, that boards or planks of different thicknesses may be tongued with one implement, and yet each may have a tongue cut upon it of a thickness adapted to that of the plank. It also enables the workman to diminish the thickness of any tongue, if found too thick for the easy putting together of his work. It also saves the trouble of keeping on hand, or carrying about, three distinct tools instead of one, to perform the three or four operations for which this implement is intended."

Claim.—"What I claim as my invention, is so making a jointing, tonguing, and rebating plane, that the jointing and tonguing of a board, while resting on its edge, and also the jointing and rebating of it while it lies on its flat side, may all be performed with one planing tool, in the manner substantially as herein described, and for the purposes herein set forth.

"I also claim making the tonguing hand plane, in such a manner as to enable the workman to make therewith tongues of various thicknesses, substantially in the manner herein set forth, whereby I prevent the necessity of providing different tools to tongue planks of different thicknesses.

"I also claim in combination with a divided body or plane stock, the two cutters, having each a cross cutting and side cutting edge, and the means, substantially as herein described, for adjusting the distance apart of the two cutters and bodies, whereby the plane is made capable of dressing the sides of a tongue to any desired thickness, and at the same time to cut the shoulders, as herein specified.

"I also claim, in combination with the gauge G, the use of the body B′, and the cross

edge of the cutter P', to constitute a jointer, to straighten the edge of a board, preparatory to tonguing it, and while resting on its edge, in a situation to receive the tonguing.

"I also claim the gauge G, in combination with the notch *p*, and the side edge of the cutter P, acting as herein described, as a jointing plane, to straighten the edge of a board or plank resting on its flat side, in a position to have a rebate cut, in the manner substantially as herein set forth."

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18. For an *Improvement in Weavers' Heddles;* Charles Tiot Judkins, Lowell, Massachusetts, February 18; anté dated December 10, 1849.

Claim.—"I declare that I do not claim metal, in combination with harness or heddles, when used in the solid state and fixed to the harness or heddle yarn at each end, such heddle yarn not being continuous, as in my invention. But what I do claim as my invention, is covering, coating, or lining the loops or eyes in heddles or harness with metal, by the process I have shown, or by any equivalent process."

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19. For an *Improved Attachment for Opening and Closing Doors or Shutters;* William Post, Flushing, New York, February 18.

"The nature of my invention refers to the use of sliding doors or shutters for closing up the fronts or open portions of stores and other buildings, and consists in the use of jibs, or swinging attachments, upon the upper edge of which the doors or shutters are run, and which may be swung in suitable directions, so as to allow of the doors or shutters being run off, and removed into a recess or space in a line forming a right or other angle with the position they occupy when used in closing the windows or other open parts; the jibs or other swinging attachments also serving to carry out the shutters when required to close."

Claim.—"What I claim as my invention, is the use of swinging attachments or jibs, for moving sliding doors or shutters, constructed and operating substantially in the manner herein shown and described."

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20. For an *Improved Snatch-Block;* Philip Rhodes, Jr., Pittsburg, Pennsylvania, February 18.

Claim.—"What I claim as my invention, is the closing up of the opening in the sides of a ship's snatch-block, by means of a gate, (E,) arranged and operating substantially as herein set forth, by which I am enabled to make the block shorter and more compact than it has heretofore been made.

"I also claim the securing the pulley axle *f* in its place, without the aid of screw and nut, or rivet heads, and in such a manner that it can be readily removed, by means of the combination of the said pulley axle with the enclosing strap C, and the gate strap D, substantially in the manner herein set forth."

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21. For an *Improvement in Planing Machines;* Daniel H. Southworth, City of New York, February 18.

Claim.—"I claim, 1st, the use of circularly grooved rollers in front of the cutter, to divide and cut the unplaned surface of the board into narrow longitudinal strips, whereby the outer shavings are taken off in narrow strings, or threads, in the manner and for the purposes herein set forth.

"2d, I do not claim simply the arrangement of the plane stocks with their cutters upon the traveling frame, in such order that one gang or set of cutters will plane one plank by their movement in one direction, and another gang of cutters plane another plank by their movement in the opposite direction, and remove the first plank planed from the bed; but this I claim, only when these are used in connexion with the circular groove serving roller, as within described."

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22. For an *Improvement in Saw Mills;* Isaac Straub, Cincinnati, Ohio, February 18.

Claim.—"What I claim as my invention, is the method of imparting a rocking or curved motion to the saw, and of straining the same by mechanical devices, substantially such as herein described."

23. For an *Improvement in Apparatus for Raising and Carrying Water;* James D. Willoughby, Scotland, Pennsylvania, February 18.

Claim.—"What I claim as my invention, is the double draft cord, so arranged and connected with the car windlass that it effects the two-fold purpose of propelling the carriage to and fro, and of turning the car windlass to unwind and wind up the bucket cord, thus ensuring the descent of the bucket into the well."

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24. For *Improvements in Knitting Machines;* John Pepper, Portsmouth, New Hampshire, assignor to Charles Warren and Horatio G. Sanford, Boston, Massachusetts, February 25; anté dated August 25, 1850.

Claim.—"Having thus described the construction and operation of my improved machine, I claim as my invention, the following new improvements:—My first improvement consists in the manner of producing the upward and downward motion, as above described, of the lead sinkers and of the jack sinkers, so far as they move simultaneously; and I claim the half jack *u*, vibrating on the comb bar P, and connected with the sinker frame, and with the movable cross bar 28, and springs 29, for the purpose of depressing the tail ends of the jack, and thereby raising their forward ends with the jack sinkers, as aforesaid.

"I also claim the movable cross bar 28, containing the springs, 29, connected as aforesaid, and for the purposes aforesaid.

"My second improvement consists in the manner of producing the backward and forward motion of the jack and lead sinkers, as above described; and I claim the cams 7, in combination with the cross bar 60, with the projections thereon, the hanging bars 8, vibrating pivots, the comb bar P, and the half jacks *u*, connected with the sinker frame as aforesaid, and for the purposes aforesaid.

"My third improvement consists in the manner of moving the carrier needle and slur knob, as aforesaid, and I claim the combination of the cam V, and the shoe and shoe plate, for the purposes aforesaid.

"I also claim the combination of the cam V, with the shoe 5, the movable shoe plate *f*, the chains *h* and *l*, the semi-circles and hub, or wheel and hub, the bar W, connected with the slur carriage and the slur knob Q, and the horizontal bar X, the carriage *q*, connected with the carrier needle q^2, for the purposes aforesaid.

"My fourth improvement consists in the manner of moving the ribbed work attachment, and producing the ribbed stitch, simultaneously with the plain stitch, without the machine slide, and with one presser, as above described. And I also claim the combination of the cams 9, with the levers 18, connected with the frame 17, and with the ribbed needle bar 16, for the purposes aforesaid; also, the same in combination with the presser *r*, connected, moved, and operating as aforesaid, and for the purposes aforesaid."

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25. For an *Improvement in Cooking Ranges;* Moses Pond, Boston, Massachusetts, February 25.

Claim.—"What I claim as my invention, is the improvements by which the hot water back is connected with the plate G, and by means of which said hot water back may be either readily removed at any time, or applied in such manner that the directions of its water pipes may be disposed so as to accommodate the bath boiler, into which they are usually led; or whatever side of the range the said bath boiler may be placed, the said improvements, consisting, 1st, in the connecting piece H, and the attachments of it, and the hot water back, the whole being made to operate together, substantially in the manner as above set forth. 2d, In a second set of attachments (fixed in the opposite face of the water back) in combination with the first set thereof, as described.

"I also claim the peculiar arrangement of flues, which lead the smoke and volatile products of combustion directly around the oven, the said arrangement of flues causing the heat to course against one-half of the bottom of the oven, next into another flue, which takes it backwards and against the other half of the bottom of the oven, thence up a flue against the back of the oven, thence through a flue extending over and against half of the top of the oven, thence into and through another flue, which carries it backwards and over and against the top of the oven, and conveys it to the chimney or discharge flue; not meaning to include in such arrangement the radiating chamber, or space, Y Z, hereinbefore mentioned.

"And I also claim the two recesses *l m*, and two flue plates *p q*, applied to the plate K,

in combination with the valve openings X A, their damper and cam plate, as applied to the top plate of the oven frame, and used under an arrangement of over flues, substantially as described, the same allowing of the adaptation of the oven to either side of the fire place, or the use of two such ovens and their frames, in connexion with the fire place, all essentially as herein before stated.

"I also claim the improvement by which the oven can be raised and readily removed, and by which the smoke is prevented from passing underneath the partition which separates the flues on top of the oven, the same consisting in the sliding or gravitating plate G', affixed to the partition, and made to operate substantially in the manner specified."

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26. For an *Improvement in the Bellows for Musical Instruments;* Marvin Smith, New Haven, Connecticut, February 25.

"My improvement consists principally in combining the reeds generally used in these and similar instruments, with an elastic wind chest, made in such a manner and of such materials as to be capable of expanding and contracting, thereby dispensing with a part or all of the common bellows used in such like instruments."

Claim.—"What I claim as my invention, is the method herein described of making or constructing the wind chest commonly used in seraphins, melodeons, and all similar musical instruments, with one or more sides, made of gum elastic, or other elastic material, and in such way and manner as to be capable of expanding and contracting, or of being increased or diminished in size, and with the aid of metallic or other springs, to answer all the purposes of the common bellows generally used in these and similar instruments, substantially as described."

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27. For an *Improvement in Applying Friction Rollers to Hubs and Axles;* Joseph B. Wilson, Townsend's Inlet, New Jersey, and Stacy Wilson, Kensington, Pennsylvania, February 25.

"Our invention consists in furnishing each wheel with a separate axle, or shaft, which is arranged to play outwards from or inwards towards the central line of the carriage, while the weight is supported on friction wheels."

Claim.—"What we claim as our improvement, in the herein described method of applying friction rollers to the axles of wheel carriages, is the interposition between the bearing of the axle and the faces of the friction rollers of a loose sleeve, through which the axle is free to slide endwise, while it, at the same time, carries the sleeve round with it, in its rotation, the sleeve having a groove in its outer periphery to receive the friction rollers, and prevent them from moving endwise on the collar."

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28. For *Improvements in Planing Machines;* John D. Beers and Isaac Winston, Philadelphia, Pennsylvania, February 25.

Claim.—"What we claim is, 1st, the combination of the shifting bed plate with the planes Z, fig. 1, constructed in the manner herein described, the planes presenting any desired part of their edge, for cutting the surface of the board, after the tonguing and grooving has been performed by the circular saws.

"We also claim as the rotating arms *h*, fig. 1, with the cover, fig. 4, combined with the plane Z, fig. 1, substantially in the manner and for the purposes herein set forth."

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29. For an *Improvement in Electro-Magnetic Engines;* Thomas C. Avery, City of New York, February 25.

"The nature of my invention consists in combining in pairs, four or more electro-magnets, so as to present their poles towards a common centre, and having space enough intervening between the poles of the magnets for an axis."

Claim.—"I claim the use and manner of arranging the helices and poles of the electro-magnets, in combination with the revolving bars, or setts of bars: that is to say, the helices being upon the bends of the magnets, from which the poles of the magnets extend towards and near to the centre of motion, and the revolving bars, or armatures, extending outwards from the centre of motion, and embracing the poles of the magnets successively, as it rotates, for producing a magnetic multiplying power engine, substantially, in parts and principle, as herein set forth."

30. For an *Improved Connexion for the Beams and Columns of Iron Buildings;* Jos. Banks, City of New York, February 25.

Claim.—"What I claim therein, is the method herein described, of securing together, the beams and columns of cast iron fronts for houses, by means of the lugs, with their flanches on the upper and under sides of the ends of the beam, and the projections on the inside, at the top and base of the columns, as herein fully shown and represented."

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31. For an *Improvement in Sad-Irons;* Edward Clapp, assignor to Edward Clapp and George Alden, Dedham, Massachusetts, February 25.

Claim.—"What I claim as my invention, is the above described improvement, in the construction of the bottom of the polishing iron, the same consisting in making it with ridges or projections, and concavities, substantially as herein before explained."

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32. For an *Improved Double-Acting Spring Hinge;* Theodore F. Engelbrecht, City of New York, February 25.

Claim.—"I wish it to be distinctly understood, that I do not claim the 'combination of an adjustable, curved, inclined plane, with a portion of a hinge, and an adjustable bearing roller, with the other portion of the hinge.' But what I do claim as new, is the manner of combining the helical springs, I and M, with the cylindrical rotating tumbler, J, and cylindrical sectional case, so that by the rotation of the cylindrical tumbler, J, the heart-shaped projection, R, will be made to traverse over the inclined plane, I, and cause the tumbler, J, to rise and fall, and thus compress and expand the helical springs lengthways, then coil, and simultaneously therewith, wind and unwind said helical springs around the spindle, F, and thus cause them to act, (by the motion of the door, in either direction,) by torsion and expansion, to close the door when it shall have been opened, as described and represented."

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33. For an *Improvement in Extension Tables;* Francis Hoguet, Philadelphia, Pennsylvania, February 25.

Claim.—"Having thus fully described the construction and operation of my improvement of extension tables, what I claim therein as new and of my invention, is the arrangement of a screw, or other equivalent device, in combination with the slides, in such a manner, that a screw, or its equivalent, of sufficient length to move out one pair of slides, will move out any number desired, substantially in the manner and for the purpose set forth."

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34. For an *Improvement in Cooking Stoves;* William Sours, Mt. Jackson, Virginia, February 25.

"My improvement consists in a new arrangement of the flues which surround the ovens, &c., by which the heat is more equally diffused throughout their extent than has been hitherto done; and by commencing the several flues at the four corners of the fire chamber, and causing them to meet and unite under the middle of the stove, their courses are made of nearly equal length, and consequently, the quantity of heated air passing through them, is equally divided between them."

Claim.—"What I claim as new therein, is the transverse partition, *c*, in combination with the arrangement of front and back flues, as above described, for causing the several currents to unite, after having traversed courses of nearly equal length, as set forth."

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35. For an *Improvement in Machinery for Turning Irregular Forms;* Abner Lane, Killingsworth, Connecticut, February 25.

"The nature of my invention consists in cutting any irregular form, by means of any required number of cutters, mounted on one or more rotary shafts, or cylinders, each and all of the said cutters being formed so as to give the required form to the article to be cut or formed."

Claim.—"I do not claim merely the employment of two or more cutter wheels, or cutter shafts, or cylinders, provided with any number of cutters, of any required form, for cutting the whole surface of, and forming articles of any irregular form without the use of the

model of the article to be formed. But I claim this, only when the cutting cylinders are sustained, revolved, and carried to and from the block to be turned, by a revolving cylinder, in whose periphery they are placed, without any longitudinal motion, while the block revolves slowly, without any longitudinal or lateral motion, substantially as described."

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36. For an *Improvement in Spring Hinges;* Henry W. Sabin and George Drew, Canandaigua, New York, February 25.

"Our improvement consists in the combination of a door hinge and spring, having a piece in the middle of the hinge, working on the same centre, but independent of either wing, to which piece, on one side, the helical spring is attached, and on the other side a projection, with a hole therein, by means of which, and a pin, the spring can be engaged and disengaged, when the door is shut, by simply inserting or withdrawing the pin, without putting an additional tension in the one case, or slacking the spring in the other. Thus, the action of the spring may be used, or dispensed with, and the door made self-closing, or not, as may be required, at any moment."

Claim.—"Having thus described our improvements, what we claim as new therein, is the piece, *f*, to one side of which the spring is attached, and which has, on the other side, a projection with a hole therein, by means of which, and a pin, the spring can be engaged and disengaged, when the door is shut, substantially in the manner and for the purposes described."

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37. For an *Improvement in Machines for Arranging and Feeding Screw Blanks;* Thos. J. Sloan, City of New York, February 25.

"The object of my invention is to take screw blanks, in the various stages of their manufacture (or pins, or other like articles,) from a hopper, into which they are thrown, and present them in regular succession to the griping jaws, in the various machines, in which they are either shaved round the head, nicked or threaded, or in which any other operation is to be performed, requiring them to be presented in succession, and each in the same position."

Claim.—"What I claim as my invention, are the lifters which select and lift the blanks, etc., from the hopper, substantially as specified, in combination with ways, or conductors, or the equivalents thereof, substantially as specified, into or on to which the blanks, etc., are transferred, as specified. And I also claim giving to the lifters or to the inclined ways, or their equivalents, a lateral motion, in combination with a stop, or detector, substantially as specified, for the purpose of arresting the operation of the lifters, until a further supply is required, as specified."

Re-issues for February, 1851.

1. For an *Improvement in Tanning Leather by Tannin and Acids;* Harmon Hibbard, Henrietta, assignor to Wm. W. Reid, Rochester, New York, patented October 16, 1849, re-issued February 11.

Claim.—"1st., I claim the process of removing hair and wool from hides and skins, and of "liming" them, so called, preparatory to tanning, by the use of a composition of lime, wood ashes, or potash, and of salt, called composition No. 1, in the manner above described.

"I also claim the use of a composition of lime and wood ashes, or potash, without the salt, but I do not claim either of these materials, separately by itself.

2d., I claim the process of tanning hides and skins, by the use of any kind of tannin, in combination either with the muriatic acid of commerce, or with muriatic acid generated by a mixture of sulphuric acid, and salt in water, with the tannin, in the manner substantially as above described."

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2. For an *Improved Arrangement of Steam Boiler and Furnace thereof;* Horace Boardman, Plattsburg, New York, patented August 14, 1849, re-issued February 25.

"My invention consists in constructing the fire chamber of a boiler, and the surrounding water space, both of increased capacity at their upper extremities, where the heat is most

intense, and in combining therewith a descending flue, by means of which the gaseous products of the combustion are conveyed downward, to be thence discharged into the chimney."

Claim.—"What I claim as my improvement in steam boilers, is the combination of a fire chamber and a water casing, the upper horizontal sections of both of which are greater than their lower, with a descending flue, the fire chamber and water casing being so arranged, with respect to each other, that the large sections of the one adjoin the larger sections of the other, substantially in the manner and for the purposes herein set forth.

"I likewise claim the injection of a jet or jets of air at the flue or passages, which connect the combustion chamber with the descending flue, for the purpose of igniting the gases, and retarding their progressive motion towards the bottom of the gas chamber."

Designs for February, 1851.

1. For a *Design for Cooking Stoves;* Samuel A. House, Mechanicsville, New York, February 4.

Claim.—"What I clain as new, is the design of cook stove, substantially the same as herein described and represented."

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2. For a *Design for Parlor Stoves;* Samuel A. House, Mechanicsville, New York, February 4.

Claim.—"What I claim as new, is the design of stove plate, substantially the same as herein described and represented."

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3. For a *Design for Umbrella Stands;* Edward J. Delany, assignor to Heins & Adamson, Philadelphia, Pennsylvania, February 18.

Claim.—"What your petitioner claims as new, is the peculiar ornamental design, or figure, as shown in the accompanying drawing."

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4. For a *Design for Cooking Stoves;* Samuel H. Sailor, assignor to Warnick, Leibrandt & Co., Philadelphia, Pennsylvania, February 25.

"The design consists in the application to stoves, with suitable mouldings, of an ornament formed by combining rays with an eye and ribbon."

Claim.—"What I claim as my invention, is the application of the above design to cooking stoves."

MARCH.

1. For an *Improvement in Paper Moulds;* William Brewer and John Smith, Surrey county, England, March 4; anté dated February 12, 1849.

"Our invention has for its object the manufacture of paper and card board, with a water mark, exhibiting an uniformity and peculiarity of design not attainable in the process of manufacture as hitherto conducted. Designs, figures, or devices, commonly called water marks, are of various descriptions, and well known; but designs, figures, or devices, as water marks, of the kind which we can produce, have hitherto been unattainable with moulds, or apparatus of the ordinary construction; and our invention consists in a new or improved mould for the manufacture of paper, for the purpose of producing better water marks therein than have been effected by moulds as ordinarily constructed."

Claim.—"We hereby declare that we claim as our invention the improved moulds for the manufacture of paper, as made in the manner herein specified, that is to say, by stamping or forming such moulds, partly or wholly, in and by dies, and afterwards removing the back of such moulds by filing, or other process analogous thereto."

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2. For *Improvements in Power Governors;* Junius Judson, Jr., City of New York, March 4.

[The publication of the description of this patent is postponed for the present, at the request of the patentee, who intends taking out patents in Europe.]

3. For an *Improvement in Calculating Machines;* John W. Nystrom, Philadelphia, Pennsylvania, March 4.

"My invention is based upon the fact that the multiplication and division of numbers may be performed by the addition and subtraction of their logarithms, and my machine is constructed in such manner that this addition and subtraction is effected by moving a pair of graduated radial arms upon a disk, on whose surface a series of curves are drawn, which, by their intersection with the arms, show the value of the result. The curves on the disk, in combination with the radial arms, serve not only to effect ordinary arithmetical calculations, but also to solve trigonometric formulæ."

Claim.—"What I claim as my invention, is, 1st, the logarithmic curves of the outer scale, in combination with the diagonals and graduated arms, the curves being laid out, substantially in the manner herein set forth.

"2d, I claim the trigonometric curves of the inner scale, in combination with the graduated arms and logarithmic curves of the outer scale, the curves being laid out substantially in the manner herein described.

"3d, I claim the two graduated arms, constructed in such manner that they can be moved in connexion or independently, substantially in the manner and for the purposes herein set forth."

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4. For an *Improved Method of Bracing the Water Spaces of Boilers;* Bernard O'Neill, Reading, Pennsylvania, March 4.

"The nature of my invention consists in the use of stationary valves, or ribands of sleeves, in the construction of boilers, fire-boxes, &c., for locomotive and other engines, for bracing and supporting the shells of said boilers or fire-boxes."

Claim.—"Having thus fully described my invention, what I claim therein as new, is the method herein described of bracing and securing the shells of boilers, or fire-boxes, of locomotive and other engines, by means of ribands of sleeves, or starting sleeves, so that when a bolt or bolts are to be removed to cure leaks, or to renew the sheets in the fire-box, the sleeves will remain in place, serving as a guide to punch the new sheets by, and affording greater support to the shells, both in backing out the old and riveting the new bolts, as herein fully described and shown."

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5. For an *Improvement in Peppermint Droppers;* Henry H. Snow, New Haven, Connecticut, March 4.

"The nature of my invention consists in the construction of a peppermint dropper, with a revolving cutter, and in the application of motion, either to such dropper, by means of a railway, the object upon which the drops are to fall being stationary, or to the object upon which the drops are to fall, and which I shall term 'the dropping sheet,' the dropper being stationary, or to both the dropper and the dropping sheet at one and the same time."

Claim.—"What I claim as my invention, is, 1st, the combination of a 'peppermint dropper,' by combining a sugar kettle with a revolving cutter. And, 2d, the combination of such dropper either with a railway, the dropping sheet being stationary, or with a movable dropping sheet, the dropper itself being stationary, or with a railway and a movable dropping sheet combined; all substantially as herein described."

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6. For a *Variable Cut-off, Regulated by the Governor;* Henry Waterman, City of New York, March 4.

Claim.—"What I claim as my invention, is regulating a variable cut-off valve, by a motion derived from and corresponding to that of the governor, by means of a toe or vibrating lever attached to the rock shaft, acted upon by revolving pins or cams, when either the cams are made to vary in position with respect to the toe, or the toe in length with respect to the cams; the whole machinery being constructed and acting substantially as herein described."

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7. For an *Improvement in Dressing Mill Stones;* Edmund P. Gaines, Nacogdoches, Texas, March 4.

Claim.—"What I claim as my invention, is the new and improved mode of dressing mill stones, which I have described above as fully and correctly as I can."

8. For a *Method of Adjusting the Stroke of Trip-Hammers;* Luther Briggs, Jr., Braintree, Massachusetts, March 11.

Claim.—"What I claim as my invention, is the construction of a trip-hammer, in which the hammer is raised by cams, not acting directly upon the hammer or the helve, or a projection from the same, commonly called the lifting leg; but by the intervention of a movable joint, so constructed as to grasp or clutch the lifting leg, at any required height, the position of the same being governed by the regulator, which may be constructed in the form of an inclined plane, or any equivalent contrivance, for raising and depressing the joint, at the will of the operator; the whole being constructed to perform the peculiar services, substantially in the manner herein before set forth in this my specification."

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9. For an *Improvement in Machines for Climbing Poles;* Henry D. Chapman, Baltimore, Maryland, March 11.

Claim.—"What I claim as my invention, is the combination of the grappling levers with the sandals and handles, for the purpose of climbing telegraph poles, masts, &c., and holding the climber at any desired height, so as to give him free use of his hands when at rest, as herein described and represented."

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10. For *Improvements in Cast Iron Car Wheels;* Perry G. Gardiner, City of New York, March 11.

"The nature of my invention consists in constructing a railroad car wheel of three principal pieces, or members of the same, which pieces are held together with screw bolts; that is to say, I make two cast iron side plates, each forming one-half of the eye, hub, arms, a horizontal or right angle flanch to the plate, for the tire to rest upon, and a vertical flanch at the outside periphery of the plate, to hold in place the tire, combined with a wrought iron tire, which, when bolted together, constitute the entire wheel."

Claim.—"I do not make any claim to the combination, self-considered, of wrought iron tire with a cast iron body, or yet for full plate sides, or for internal arms in section, when cast solid with the side plates of a railroad car wheel, for such have all been known and used before; but what I do claim as new, is the precise manner in which I have constructed and put together the parts of my wheel, by which, thus formed, they are free of strain from shrinkage in cooling, and have semi-internal flanches, as described, to protect the wheel when in use against lateral strain, and are bolted together and combined with a wrought iron tire, in the manner set forth."

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11. For an *Improvement in Machinery for Making Tires by Continuous Rolling;* Perry G. Gardiner, City of New York, March 11.

Claim.—"What I claim as new, is stopping the advancing movement of the movable towards the stationary roller, when the tire shall have attained its proper section, by means of self-acting mechanism, acting and constructed substantially as herein described.

"I also claim the combination of belts, pulleys, clutches, screws, and screw wheels, with the sway-bar and triggers, by which a self-acting, advancing, and retrograding motion is given to the movable roller, each motion changing to the other, when caused so to do, by the hand of the operator, but self-arrested and stopped by the set of the triggers, substantially as specified."

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12. For an *Improvement in Connecting Trucks with Car Bodies;* Thomas P. How, Buffalo, New York, March 11.

Claim.—"What I claim as my invention, is connecting the bodies of cars to the trucks by two bolts to each truck, working in the holes or mortises above described and represented; the whole being constructed and operating substantially as herein set forth."

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13. For an *Improved Use of Slides in Bee Hives;* Nathaniel Potter, Buffalo, New York, March 11.

Claim.—"Having thus fully described my invention, what I claim therein as new, is the manner herein described of arranging the moth apartment with glass, paper, or other

thin material, overlaying the vent holes in the top of the box, said glass or paper having placed upon it old comb, or other suitable material, so as to be warmed by the bees in the boxes below, and ventilated as described, thus attracting the moths into said apartment, while they are at night entirely excluded from the bee boxes by means of the ventilating buttons, as described.

"I also claim the arrangement by which the upper box or boxes are held in their places, while the one below is removed, and another inserted in its place.

"Also, the arrangement at the rear and bottom of each box, by which the tin slide is removed, thus allowing a convenient opportunity for clearing the bottom of the bee box, as described."

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14. For an *Improved Window Curtain Fastening;* Hugh Guyer, Albany, New York, March 11.

Claim—"I claim the construction of rack pulleys for window shades, by fixing the pulley over which the cord of the shade roller runs, upon a stem, having a plate sliding on the front outer face of the rack box, attached to a thin plate or fan passing through a slot in said face, extending the length of the box, the said pin projecting upwards and terminating in a point, which acts as a pawl against ratchet teeth made in the bottom of said box, or else the said pin projecting downward, and having a cross pin through it, acting against ratchet teeth in the upper and inner side of said box; the said stem and plate, in addition to the sliding motion along the box, having an oscillating motion on the upper or lower edge of the plate, by means of which the upward pressure of the cord on the pulley holds the pawl or pin against the ratchet teeth, the downward pressure of the hand carries the pawl or pin out of the line of the teeth, and permits the pulley to be moved upwards when required, substantially as set forth in this specification."

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15. For *Improvements in Steam Drilling Machines;* Joseph W. Fowle, Boston, Massachusetts, March 11.

"In machines which have been recently devised for splitting and dressing stone, &c., by steam, the dressing or cutting tool has been so connected to the piston rod as to be worked by the direct action of the steam. This feature I have incorporated in my improvements, and I have also combined with it an arrangement for supporting the engine, and the drilling tool which it drives, in a frame which may swing and be raised and lowered, so as to drill in any direction and at any height; also, a mechanical provision for turning the tool, and one for advancing it as the drilling progresses; and furthermore, an improved mode of preventing the direct action of the steam from throwing the piston, as the tool is drawn forward and back, through either head of the cylinder."

Claim.—"What I claim as my invention, is the combination of a direct action steam drill, in which both engine and drill are mounted on a frame, which slides in a swinging frame, capable of being adjusted in any required position with the apparatus, substantially as herein above described, which is connected with and actuated by the cross head of the engine for causing the sliding frame to move along the swinging frame towards the rock."

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16. For an *Improvement in Air-Tight Franklin Stoves;* Rensselaer D. Granger, Albany, New York, March 11.

Claim.—"What I claim as my invention, is making the fire-box with closed plate in front and behind, with a grate surface at bottom, occupying about one-third of the space between the front and back stove plates, to constitute hot air chambers front and back, when such fire-box is combined with a sliding damper at bottom, substantially as and for the purpose specified.

"And I also claim, in combination with a fire chamber constructed as above specified, and governed at bottom with a sliding damper, as specified, the open front with vertically sliding doors, as described, and for the purpose specified."

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17. For an *Improvement in Securing Daguerreotypes in Monumental Stones;* Solon Jenkins, West Cambridge, Massachusetts, March 11.

Claim.—"What I claim as my invention, is the mode herein described of securing the portrait plate against injury (from moisture or otherwise) by means of the two glass

plates D and F, the plate I, and the back of plate H, the whole being arranged and combined substantially as herein set forth."

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18. For an *Improvement in Cooking Stoves;* James Greer and Rufus J. King, Dayton, Ohio, March 11.

"The great difficulty in cooking stoves is to equalize the heat and to cause it to act on all parts of the ovens alike; after various trials, we have jointly invented a stove with two ovens, in which we attain an equalization of the heat, by arranging three sets of diving flues, which extend athwart the whole breadth of the stove, except at the front fire doors and the central ascending flue in the back. We have also jointly invented a gravitating damper, the facility in making and in operating which makes it answer the purpose required, to our full satisfaction."

Claim.—"Having thus fully and clearly described the nature, construction and operation of our joint invention, what we claim therein as new, is the combination of the diving flue *d* as described, with the diving flues *a* and *f* as described, the said flues occupying the whole breadth of the stove, with the exception of the space occupied by the fire doors and the central reverting flue in the back.

"We also claim the gravitating damper *l*, operated as described, that is to say, by the rod *n*, with its curved eye *m*, and the pendent lever *i*, with its bend *p* and catch *o*, the said damper being located upon the division plate between the back diving flues and the central back reverting flue."

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19. For an *Improvement in Piano-forte Action;* John Ruck, City of New York, March 11.

Claim.—"What I claim as new in my invention, is, 1st, hanging the hammer shank on a hinge or joint *d* at a distance from its end, and effecting its communication with the fly lever or jack by means of a lever L, which is hung on a fulcrum *i* at a distance from either end, and is connected at one end by a hinged or jointed link with the end of the hammer shank, in such a manner, that when the fly lever is raised by the key, the end of the hammer shank is drawn down and the hammer thrown up to the string, or by any other means, substantially the same.

2d, "The universal repeating spring *m*, is attached to the lever or butt upon which is formed the projection *k*, or its equivalent, through which the fly lever communicates with the hammer for the purpose of raising it, and working upon the end of the fly lever, in the manner substantially as and for the purpose herein set forth: this I claim without reference to the precise form of the projection, or of the spring herein shown, as various modifications may be made for producing the same effect.

3d, "Attaching the check wire to a hanging or hinged butt *q*, operated upon by the key in the manner substantially as described, so as to produce the same effect as if attached to the key, for the purpose of allowing the key to be easily taken out.

4th, "Securing or placing the regulating screw *r*, for controlling or regulating the escapement of the fly lever, in an arm N or its equivalent, upon the lever upon which the fly lever acts, by which the action of the said screw upon the fly lever is more gradual and easy, and the jarring or concussion produced when the screw is stationary is avoided."

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20. For an *Improvement in Machines for Turning, Boring, &c.;* Martin Way and Thos. R. Way, Paintersville, Ohio, March 11.

"Our machine is constructed to bend metals to curves, to any required radius, and to bore, drill, and turn, both wood and metals: it is particularly applicable to the business of carriage making, as it embodies in a single machine the means of effecting many of those mechanical operations which are required in constructing wheel carriages, and which have heretofore been effected in separate machines."

Claim.—"What we claim in the foregoing as our invention, is the tool and block holder herein described, consisting of two upright frames, capable of movement towards each other, and of being clamped at a greater or less distance apart, as may be required, to adapt them to holding blocks of different sizes, and tools of different lengths or forms, each frame being provided with upright parallel guides, carrying adjustable jaws, for holding, boring or turning tools at different heights and angles, and to aid in holding blocks of irregular forms, these frames being mounted upon a carriage capable of being turned or moved, right or left, so as to hold the tool, or present the substance to be bored, in the required position, substantially as herein set forth."

21. For an *Improvement in Copying Presses;* A. A. Wilder, Detroit, Michigan, March 11.

"The nature of my invention consists in the use of two flat pressing plates, one of which being vertical, works on a slide. and has an adjusting screw for regulating the degree of pressure or width between the plates, according to the thickness or the nature of the material being pressed, and the second plate being fitted so in the table or bed plate, that it may have a movement so as to open like a hinge; and it possesses, also, an adjusting screw or box, through which the screw pin passes, and which is attached by link rods to the handle or lever, having its fulcrum on the opposite plate; the loose or hinge hung plate, being opened and shut by the motion up or down of the lever handle, which produces the pressure."

Claim.—"What I claim as my invention, is the use of a lever handle I, having its fulcrum on the pressing plate B, attached to the opposite plate F by links H H, as shown, working in the manner described, in combination with the adjusting arrangements C E G *g*, for the purposes expressed, and operating together as shown, or in any other substantially similar manner."

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22. For an *Improvement in the Teeth of Saws;* George F. Woolston, Orangeburg, South Carolina, March 11.

Claim.—"I claim as my invention, the invention of teeth in circular saw blades, of the form and for the purpose above set forth."

DISCLAIMER.

1. For an *Improvement in Machines for Making Wire Heddles;* Abijah J. Williams, Utica, New York; patented September 11, 1849, date of disclaimer February 24, 1851.

"The subscriber further represents, that he is the sole and exclusive owner of the said letters patent, and of the right, interest and property therein and thereby secured; and although he did not intend, in or by the specifications and drawings upon and in reference to which said letters patent were issued, (and of which copies are annexed to, and form a part of said letters patent,) to represent or claim that he was the original or first inventor of the wheel, collar, or flanch, with a sliding tooth and pulley, and treddle, or other device, hereinafter particularly mentioned, or of any part thereof; and he insists that said specifications and drawings do not, when rightly understood, represent or claim that he was such inventor; and he also insists, that said letters patent do not, when rightly understood, assume to confer on him any right, as the supposed assumed or alleged inventor thereof, or of any part thereof; yet, in order to guard against any mistake or misconstruction, in these respects, the subscriber states,

1. "That he did not mean to assert, claim or represent, in and by said specifications or drawings, that he was the original or first inventor of the wheel mentioned as wheel, fig. 8, in said specifications and drawings.

2. "Nor did he mean to assert, claim or represent, in and by said specifications or drawings, that he was the inventor of the collar or flanch, with a sliding tooth, which are partially represented on the drawing, figure 1, near letter Q. and also partially represented on the drawing figure 2, at that end of the cylinder where the receiving and discharging hook rod shows the hook, and near letter B.

3. "Nor did he mean to assert, claim or represent, in and by said specifications or drawings, that he was the inventor of the cord pulley or heddle, partially represented on the drawing, figure 1, which cord, as there shown, extends from said pulley, near letter C, to said heddle.

4. "Nor did he design or intend by said specifications or drawings to claim, assert, or represent, that his invention would make a heddle, with a slack twist in the half, or part thereof, which is towards the end where the wire is doubled.

"And the subscriber says, that if said specifications and drawings import or mean that any or either of the aforesaid things was or were invented by him, or that his invention, as claimed by him; would make a heddle with any such slack twist, as aforesaid, the same was and were, by and through inadvertence, accident and mistake, not being so designed or intended by him, and he hereby fully disclaims the several matters and things aforesaid, numbered above 1, 2, 3, 4, and each and every part thereof, under and pursuant to the seventh section of the Act of Congress, entitled "an Act in addition to the Act to promote the progress of science and useful arts," approved March 3d, 1837, and under and pursuant

to the law in such cases made and provided; insisting, however, as he does, that the same are not, nor is any part thereof, claimed in and by said specifications and drawings, or either of them, or embraced in said letters patent; this disclaimer being made for greater caution, and to guard against misconstruction and mistake in regard to said matters."

MECHANICS, PHYSICS, AND CHEMISTRY.

Marble Sawing and Polishing Machinery, Worked by Steam Power. By Charles Holtzapffel.*

Marble has of late years been extensively worked by machinery driven by steam power; the processes are closely analogous in principle to those pursued by hand, but with various modifications of the apparatus, and it is now proposed to explain briefly some of the peculiarities of the machine processes.

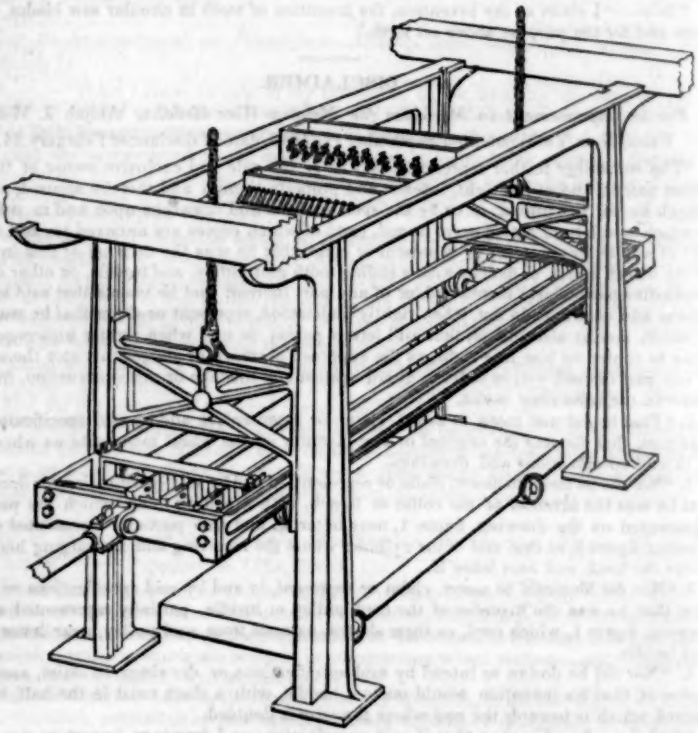


Fig. 1.

In the simplest application of machinery to sawing marble, as for making one or two cuts in a large block, the construction of the ordinary stone saw is closely followed, but the frame is made much stronger, of squared

* From the London Artizan, for January, 1851.

timber firmly bolted together, and stayed with chains; to constitute three sides of a rectangular frame; the place of the pole and tightening chain of the saw, is occupied by two fixed beams, and the saw is held and stretched by means of two clamps, with screws passing through the ends of the frame, and tightened by nuts on the outside. The saw frame works between vertical guide posts to keep it upright, and it is reciprocated horizontally by a connecting rod fixed to a crank driven by the engine. The connecting rod is attached to the frame by a loop, which can be placed at various heights so as always to keep the stroke of the connecting rod nearly horizontal, notwithstanding the gradual descent of the saw in the cut.

These saw frames are sometimes made as large as 16 feet long, and 10 feet high, for cutting huge blocks of marble; and to prevent the great weight of these frames from pressing on the cut, they are suspended at each end by chains or slings which vibrate with the saw, and are connected with a counterpoise weight, that is adjusted to allow of the necessary pressure for the cutting, which is effected with sand and water supplied in the same manner as for the stone saw used by hand, but the introduction of the guide principle, renders the chasing of the stone for the entry of the saw unnecessary. In some cases smaller saws of similar construction are used for cutting thick slabs into narrow slips, and sometimes several cuts are made at once by an equal number of saw blades, arranged in a rectangular frame, that is suspended horizontally by vibrating slings, and works between vertical guide posts.

In the horizontal sawing machine for marble patented by Mr. James Tulloch in 1824, the entire arrangements are combined in a very effective manner, for cutting a block of marble into a number of parallel slabs, of any thickness, at the one operation. The iron framework of the machine, shown in fig. 1, consists of 4 vertical posts strongly connected together at the top and bottom, to form a stationary frame from 10 to 14 feet long, 4 to 5 feet wide, and 8 to 12 feet high, within which the block of marble to be sawn is placed. The two upright posts at each end of the stationary frame have, on their insides opposite to each other, perpendicular grooves, within each pair of which slides up and down a square vertical frame; to the lower end of each of these slides is affixed a spindle carrying two guide pulleys, or riggers, upon which the horizontal saw frame rests, and is reciprocated backwards and forwards. The saw frame is thus traversed within the fixed framing, and supported upon the four guide pulleys of the vertical slides, which latter are themselves suspended by chains coiled upon two small drums placed overhead. On the same spindle with the drums is a large wheel, to which a counterpoise weight is suspended by a chain. The weight of the counterpoise is so adjusted as to allow the saw frame to descend when left to itself, and which thus supplies the necessary pressure for causing the penetration of the saws.

The saw frame is made rectangular, and from 2 to 3 feet longer than the distance between the vertical slides, in order to permit of the horizontal traverse of the saws, which is from 18 to 20 inches. To allow of the blades being fixed in the frame with the power of separate adjustment, every blade is secured by rivets in a clamp or buckle at each end; the one extremity of the buckle embraces the saw, the other is made as a hook, the

buckle at one end of the saw is hooked upon a horizontal bar fixed across the end of the saw frame, and the opposite end of the frame has a groove extending its entire width, through which a separate hook, provided with a vertical tightening wedge, is inserted for every saw, which thus admits of being replaced without deranging the position of the neighboring blades.

The distances between the saws, and their parallelism with the sides of the frame, are adjusted by means of iron blocks made of the exact thickness required in the slabs of marble; the blocks and blades are placed alternately, and every blade is separately strained by its tightening wedge until it is sufficiently tense; the blocks are sustained between two transverse bars, called *gage bars*, and are allowed to remain between the blades to give them additional firmness.

The traverse of the saw frame is given by a jointed connecting rod, attached by an adjustable loop to a long vibrating pendulum, that is put in motion by a pair of connecting rods, placed one over the other, and leading from two cranks driven by the engine. All three connecting rods admit of vertical adjustment on the pendulum. The connecting rod of the saw frame is placed intermediately between the other two, but its exact position is regulated by the height at whtch the saws are working, as it is suspended by a chain and counterpoise weight, which allow it to descend gradually downwards on the pendulum, with the progress of the cut, so as always to keep the connecting rod nearly horizontal.

In the London Marble Works four of these sawing machines of different sizes are grouped together, with the driving shaft and pendulums in the middle, and so arranged that each pair of saw frames reciprocate in opposite directions at the same time, in order to balance the weight, and reduce the vibration.

Another mode of traversing the saw frame sometimes adopted, is by means of a vertical frame that is reciprocated horizontally on slides, and the connecting rod, instead of being jointed, is fixed rigidly to the saw frame, and slides upon a vertical rod. Various other unimportant modifications in the construction of the machines are also adopted.

One of the most difficult points in the application of these machines, was found to be the supplying of the sand and water mechanically to the whole of the cuts at the same time. This is now successfully effected by the following arrangement. Above the block of marble to be sawn is fixed a water cistern, or trough, extending across the whole width of the frame, and measuring about 1 foot wide and 1 foot deep; about 20 small cocks are arranged along each side of the cistern, and a small but constant stream from each of the cocks is received beneath in a little box; a sloping channel leads from every box across the bottom of a trough filled with sand, which mingles with the water, and flows out in separate streams, that are conducted to each of the saw cuts. In the first construction of this apparatus for the feed, the sloping channels were led straight across the bottom of the sand trough, but it was then found that the water excavated little tunnels in the sand, through which it flowed without carrying the sand down. This difficulty was overcome by leading the channels across the bottom of the trough in a curved line, when viewed in plan. The form of the channels is shown in fig. 2, which represents four channels cut across the middle of their length, to show their section, from which it will

be seen that the channels are made as a series of Gothic shaped tunnels, supported only on one side, and open on the other for the admission of the sand; the water flows through these tunnels, and continually washing against the convex side of the channel, undermines the sand, which falls into the water and is carried down: to assist this action the attendant occasionally stirs up the sand to loosen it. There is a sand trough and set of channels on each side of the water cistern, so that every saw cut receives two streams of sand and water in the course of its length.

The saws having been adjusted to the proper distances for the required slabs, the saw frame is raised by means of a windlass and the suspended chains attached to the vertical frames, and the block of marble to be sawn is mounted upon a low carriage, and drawn into its position beneath the saws, and adjusted by wedges. The saws are then lowered until they rest upon the block, the counterpoise weights are adjusted, and the mixed sand and water allowed to run upon the saw blades, which are put in motion by attaching the connecting rod to the pendulum. The sawing then proceeds mechanically until the block is divided into slabs, the weight of the saw frame and connecting rod causing them gradually to descend with the progress of the cutting.

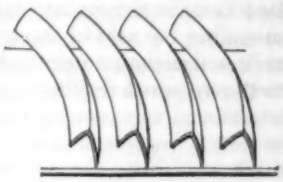


Fig. 2.

To allow the sand and water to flow readily beneath the edges of the saw blades, it is desirable that the horizontal frame should be slightly lifted at the end of each stroke. This is effected by making the lower edges of the frame, which bear upon the guide pulleys, straight for nearly the full length of the stroke, but with a short portion at each end made as an inclined plane, which on passing over the guide pulleys lifts the frame just sufficiently to allow the feed to flow beneath the saws.

For cutting slabs of marble into narrow pieces, such as shelves, and which is effected by hand with grub saws, a machine called a *ripping bed* is employed, in which as many cuts as may be required in the one slab are effected simultaneously, by an equal number of circular saws with smooth edges, revolving vertically, and fed, as usual, with sand and water. This machine, represented in fig. 3, consists of a bench about 12 or 14 feet long, 6 or 7 wide, and about 2 feet 6 inches high; upon the top of the bench is fixed two rails, upon which a platform, mounted on pulleys, is drawn slowly forward by a weight. The horizontal axis carrying the saws revolves about 9 inches above the platform, and to ensure the rotation of the saws, the axis is provided with a projecting rib or feather extending its whole length. The saws are made as circular plates, about 17 inches diameter when new. The saws, or cutters, are clamped between two collars about 6 inches diameter, fitted so as to slide upon the spindle, and be retained at any part of its length by side screws.

The saws having been adjusted to the required distances for the widths of the slips to be cut, and fixed by the side screws, the slab of marble is embedded in sand upon the platform, and the edge of every saw is surrounded on one side with a small heap of moist sand. The saws are then set in motion, so as to cut upwards, and the platform is slowly

traversed under the saws by the weight, which keeps the slab of marble constantly pressing against the edges of the revolving saws, until the slab is entirely divided into slips.

When the saws are new, they nearly reach the upper surface of the platform, and a moderate thickness of sand, just sufficient to form a bed for the slab of marble, raises it high enough to allow the saws to pass entirely through the thickness of the slab; but as the saws are reduced in diameter by wear, it becomes necessary to employ a thicker layer of sand, or to use a supplementary platform to raise the slab to the proper height. To avoid this inconvenience, an improvement has been recently introduced by mounting the axis of the saws in a vertical slide, which is adjusted by a rack and pinion, so as to allow the edges of the saw to penetrate exactly to the required depth.

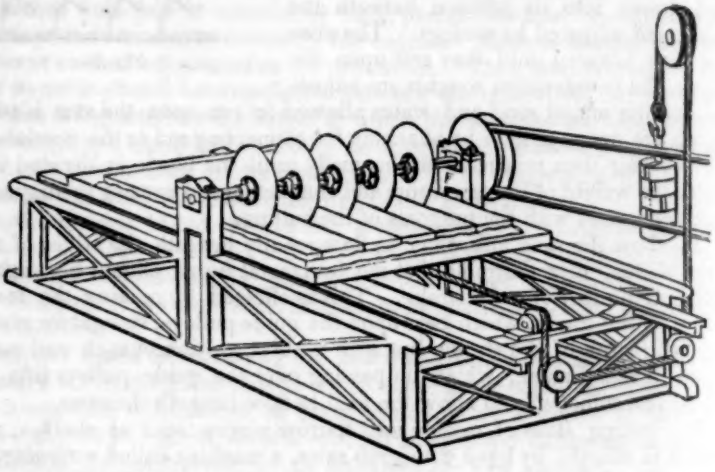


Fig. 3.

Circular pieces of marble, such as the tops of round tables, and other objects, from about 6 feet diameter to the small circular dots sometimes used in tesselated pavements, are sawn to the circular form by means of revolving cylindrical cutters, constructed on much the same principle as the crown saws for wood. The slab to be sawn is placed horizontally on a bench, and the axis of the machine works vertically above it in cylindrical bearings, which allow the spindle to slide through them, so as to be elevated or depressed according to circumstances. The spindle is suspended at the upper end by a swing collar attached to a connecting rod, that is jointed to the middle of a horizontal lever. The weight of the vertical rod and cutter supplies the pressure for the cutting, and the whole is raised for the admission of the work by a rope attached to the end of the lever, and passed over a pulley, as shown in fig. 4.

For circles of small diameter, the cutters are made as hollow cylinders of sheet iron of various diameters, and each attached by screws to a circular disk of cast iron, as shown in section in fig. 6. The cutter is screwed on

the lower end of the spindle, just the same as a chuck on a lathe mandrel, except that the cylinder is placed vertical instead of horizontal. To ensure free access for the sand and water beneath the cutter, one or two notches, about three-quarters of an inch wide, are generally made in the lower edge.

For large circles, the apparatus is made stronger than that shown in fig. 4, and the vertical spindle is fitted at its lower extremity with a circular plate, to which is bolted a wooden cross, shown in plan in fig. 7, and in elevation in fig. 8; the cross has radial grooves about 18 inches long near the outer extremities of the four arms. The cutters consist of detached plates of iron from 6 to 18 inches long, of various widths, according to the thickness of the work. The cutters are curved as segments of a cylinder, of the particular diameter they are required to cut, and are each riveted to a clamp that passes through the radial groove, and is retained by a wedge. The number and length of the cutters is solely a matter of convenience, as a single cutter, when put in rotation, would make a circular groove, and several cutters are only employed in order to expedite the process. But every different diameter requires a different curve in the cutters, and which must all be placed at exactly the proper distance from the centre of rotation.

Fig. 4.

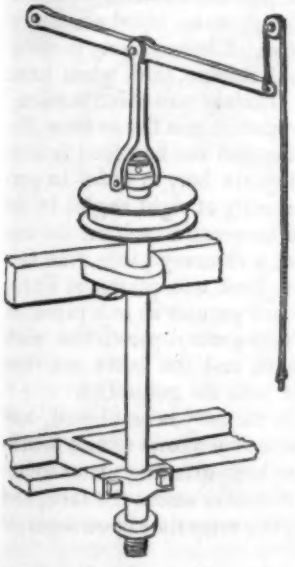


Fig. 5.

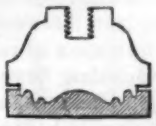


Fig. 6.

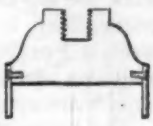


Fig. 7.

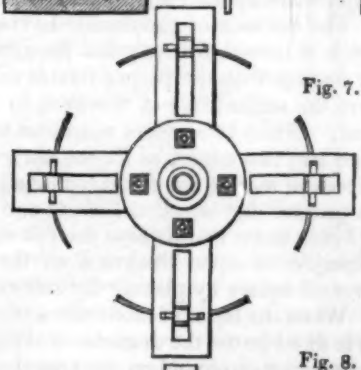
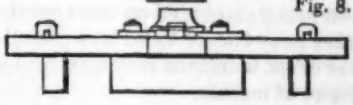


Fig. 8.



The horizontal bench upon which the marble is laid, is generally a temporary structure, adjusted to suit the thickness of the object to be sawn. Works of large diameter are seldom more than one or two inches thick, but those of small diameter are frequently much thicker, and sometimes three or four thin pieces are cemented upon each other, and cut at one operation. Short pillars are sometimes sawn out of an irregular block in a similar manner, instead of being chipped and turned. And it has been

proposed that long cylinders, and tubes of stone, should be cut with cylinders of sheet iron of corresponding length, put in rotation, and supplied with sand and water.

Marble works of small and medium size, are ground flat upon horizontal revolving laps, after the same general method as that pursued by the lapidary, but with a proportionate increase of size in the lap, which is supplied as usual with sand and water. The laps for marble works are made as circular plates of cast iron, from 6 to 14 feet diameter, and about 3 inches thick when new; they are mounted in various ways upon vertical spindles, so that their upper sides or faces may be about 2 feet 6 inches above the ground. Across the face of the lap, or as it is called the *sanding plate*, one or two strong square bars of wood, faced with iron, are fixed so that their lower sides may just avoid touching the face of the lap, and their edges present perpendicular faces, from 5 to 6 inches high, at right angles to the face of the lap. The wooden bars serve as stops, to prevent the work from being carried round by the lap, and also as guides to ensure the work being ground square.

The piece of marble is laid flat upon the lap, with the face to be ground downwards, and the side of the work in contact with the guide bar. Water is allowed to drip upon the plate from a cistern fixed above, and small quantities of sand are thrown on as required. During the progress of the work the workman leans upon the marble, the position of which is shifted occasionally, to expose both the work and the lap to an equal amount of wear, and prevent the formation of ridges, but which is less likely to occur with iron laps used for grinding large surfaces of marble, than when small objects are applied upon lead laps, as by the lapidary and mechanician.

The one side of the marble having been reduced to a flat surface, the work is turned over to grind the adjoining face, and the first face is held in contact with the perpendicular side of the guide bar, in order to present the second face of the work to the lap exactly at right angles to the first. When two pieces of similar size are to be ground each on the one face and two edges, as for the upright sides of a chimney piece, the two pieces of marble are cemented together back to back with plaster of Paris, (a process that is called *lining*,) and the pair are ground as one piece on all four faces; in this case the flat sides are first ground parallel to each other, or of equal thickness on the two edges, and the latter are then ground square by placing the sides in contact with the guide bar.

When the lap is of moderate size, one guide bar only is employed, and it is fixed across the diameter of the plate, which then allows of two workmen being employed on the opposite sides; but large grinding plates sometimes have two or three bars placed at equal distances across the face, and four or six workmen may then be employed at the same time upon separate pieces of marble.

The sand and water are continually thrown from the lap by the centrifugal force, and the large size of the works sometimes applied, prevents the use of a rim standing up above the level of the lap to catch the wet, as used by lapidaries. Every workman, therefore, stands within a kind of trough like a box, about three feet high, without a top or back; the troughs serve as a protection to the workmen, who would otherwise be exposed to a continued shower of sand and water.

The surfaces of large slabs are in some cases ground upon revolving plates; in this case the axis is placed entirely beneath the surface of the plate, somewhat as in fig. 9, and the slab is traversed by two men over the face of the plate to grind it equally; but the machine next described is better adapted for large slabs of marble requiring tolerable accuracy.

Large slabs of marble and stone are ground very accurately in a machine patented by Mr. Tulloch, and called a grinding bed. In this machine, represented in fig. 9, the slab to be ground is placed horizontally upon a moving bed, and the grinding is effected by sand and water, by means of a large flat plate of iron resting upon the surface of the slab. The two surfaces are traversed over each other with a compound motion, partly eccentric and partly rectilinear, so as continually to change their relative positions. The machine consists of a frame about 9 feet long, 6 feet wide, and 8 feet high; about 2 feet from the ground is mounted a platform, that is very slowly reciprocated horizontally for a distance of from 1 to 2 feet, according to the size of the slab, by means of a rack and pinion placed beneath, and worked alternately in both directions.

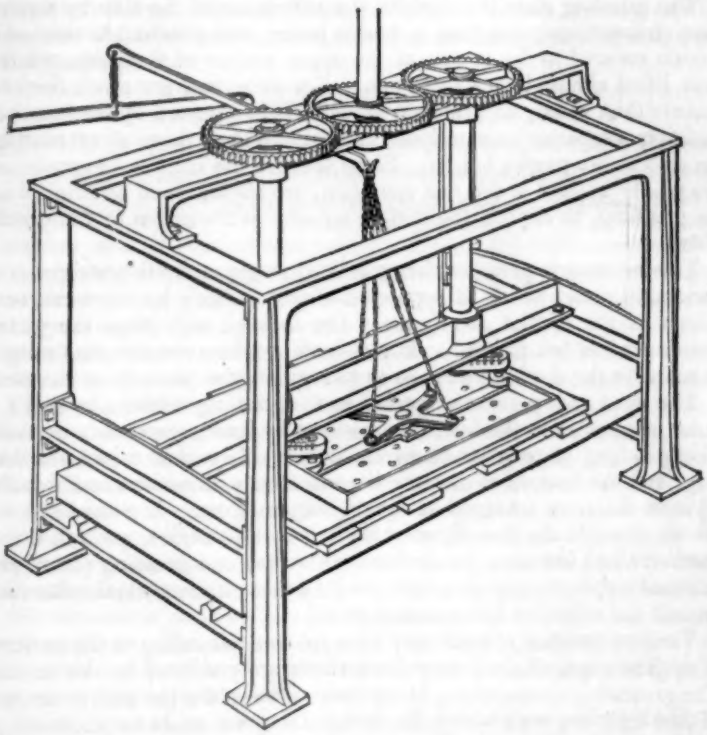


Fig. 9.

Above the platform are fixed vertically two revolving shafts, having at their upper extremities horizontal toothed wheels of equal diameter, which are driven by means of a central toothed wheel keyed on the driving shaft.

The two vertical shafts are thus made to revolve at equal velocity or turn for turn, and to their lower ends are attached two equal cranks placed parallel to each other, the extremities of which therefore describe equal circles in the same direction. To these cranks the iron grinding plate or runner is connected by pivots fitting two sockets placed upon the central line of the plate. The cranks are made with radial grooves, so that the pivots can be fixed by wedges at any distance from the centre of the cranks. When the machine is put in motion the grinding plate is thus swung round bodily in a horizontal circle of the same diameter as the throw of the cranks, which is usually about 12 inches, and consequently every portion of the surface of the grinding plate would describe a circle upon the surface of the slab being ground if the latter were stationary. But by the slow rectilinear movement of the platform the slab is continually shifted beneath the plate, so as to place the circles, or rather the cycloids, in a different position, and it is only after many revolutions of the cranks that the same points of the surfaces of the grinding plate and slab are a second time brought in contact.

The grinding plate is raised for the admission of the slab by means of four chains suspended from a double lever, and attached to the arms of a cross secured to the centre of the upper surface of the plate, which is thus lifted almost like a scale pan. For slabs that are much thicker or thinner than usual, the principal adjustment is obtained by the removal or addition of separate beds, or loose boards, laid upon the platform to support the slab at the proper height. Slabs that are too large to be ground over the whole surface at the one operation, are shifted once or twice during the grinding, to expose the surface equally to the action of the grinding plate.

The necessary pressure for grinding, is given by the weight of the horizontal plate, which is supported almost entirely by the work, as the pivots of the cranks merely enter the sockets, and allow the plate to descend when left to itself. For delicate works a counterpoise weight is attached to the double lever, so as to regulate the pressure on the work.

The sand and water are applied to the grinding surfaces in much the same manner as in the iron runners used by hand, previously described. The grinding plate is made on the upper side with a raised rim like a tray, and the bottom of the tray is perforated with numerous holes about 1½ inch diameter arranged at equal distances apart. The sand and water are thrown into the tray at intervals in small quantities, and run through the holes and between the surfaces of the slab and grinding plate, which are thus uniformly supplied with the feed that ultimately makes its escape around the edges of the grinding plate.

Various qualities of sand may be employed according to the perfection of surface required, and very flat surfaces are produced by this machine. The *grounding* or smoothing of the best works is effected with a succession of fine emeries, with which the surfaces may be made very smooth, and almost polished; but from motives of economy, the grounding of ordinary works is more frequently completed by hand, with grit stone and snake stone, before the work is finally polished on another machine.

Rectilinear mouldings in marble are wrought by machinery in a manner

altogether different from the hand process of working mouldings, in which, as previously described, nearly the whole of the material is removed with chipping chisels, and the surfaces of the mouldings are only smoothed by abrasion. In the machine process, on the contrary, the whole of the material is removed with revolving grinders, by which the work is reduced to the required form, and left smooth at the one operation.

The machine for working rectilinear moulding, or as it is called *the moulding bed*, closely resembles in its construction the ripping bed described previously, except that the frame carrying the revolving grinders is provided with the power of vertical adjustment by a screw placed beneath, in order to raise the grinder to the proper height to suit the thickness of the marble, and that instead of the grinders being thin circular sheets of iron, they consist of solid cylinders of cast iron turned to the counterpart forms of the required mouldings, indeed the ordinary ripping bed is occasionally used for working mouldings on large works, and when it is provided with the vertical adjustment for elevating or depressing the axis to any required position, the ripping bed is equally suitable for working mouldings; but as the latter are in general only required on slips of marble only a few inches wide, a narrow machine is usually employed for the purpose.

On the Use of Caustic Lime, instead of Limestone, in Blast Furnaces; By E. Montefiore Levi, *Engineer of the Ougrée Blast Furnaces, and* Dr. Emil Schmidt, *Engineer of the Royal Austrian Company.* *

Having, in 1849, undertaken a series of very extensive researches on the composition of the gases of the large coke furnaces used at Ougree, researches which we have been prevented by other occupations from bringing as yet to a sufficiently successful termination to offer them to public appreciation, but which have furnished several very interesting results, we took a portion of gas from foot to foot from the tuyere to the mouth of a furnace, 54 feet in height, each time estimating the proportion of carbonic acid; this examination, the details of which we reserve for an ulterior communication, demonstrated clearly that very nearly the whole of the carbonic acid disengaged from the limestone is converted into oxide of carbon in its passage through the incandescent coke. We observed that the decomposition of the limestone takes place much lower in the furnace than is generally supposed, and that at the point where that decomposition takes place, the temperature is sufficiently high to allow the carbon of the coke to be absorbed by the carbonic acid evolved from the carbonate of lime. The quantity of coke thus uselessly consumed is very considerable, as the following calculation, deduced from the actual present working at Ougree, will plainly show:—

A blast furnace, smelting 53 tons of 38 per cent. ore every 24 hours, will produce about 20 tons of iron—if, as at Ougree, 40 per cent. of limestone are used, the total quantity is about 21 tons, containing about 9½ tons of carbonic acid; the coke consumed when limestone was used was about 150 for 100 of pig-iron, or about 30 tons per diem. Now, 9½ tons

*From the London Mining Journal, No. 802.

of carbonic acid may be converted into oxide of carbon by the absorption of about 2 tons 12 cwts. of carbon, or 2 tons 18 cwts. of coke with 11 per cent. of ash, the proportion of coke, which is hereby uselessly absorbed, is equal to 9·74 per 100 of the total quantity which is charged into the blast furnace. Struck with this remarkable result, we acquired the conviction that, notwithstanding the fuel and labor necessary for the manufacture of lime in separate kilns, there would yet be a real and considerable advantage gained by using it instead of limestone; the fuel generally used for lime burning is of inferior quality, and as its combustion is so managed that it is converted in burning into carbonic acid, a maximum proportion of the heat that it can produce is rendered available; it appeared to us, moreover, evident that, the great absorption of heat by the carbonic acid in its passage from the solid to the gaseous state no longer taking place, not only could the quantity of ore charged for a given proportion of coke be augmented, but, moreover, as the elaboration of the ore would take place at a higher point of the furnace, the descent of the charges might be hastened, and the production of the furnace augmented.

Consequently, carrying our ideas into practice, in the month of June, 1849, lime was used in lieu of limestone in the furnace No. 3 of Ougree. The result during the few first days did not answer our expectations, but we were not long in discovering the cause of this unsuccessful result. No more than the theoretical proportion of lime had been used, that is to say, 56 for 100 of the carbonate; but, necessarily, it was very far from being pure; there was, therefore, an insufficient quantity, and thence dark colored slags and difficult working. This fault was promptly remedied by an augmentation in the proportion of lime, which was carried to 63 for 100 of limestone. From that moment, the behavior of the furnace became most regular and excellent; the proportion of ore was augmented, and the number of charges multiplied. From that period lime has constantly been used in that furnace, and invariably with the most favorable results. Eighteen months continual use of lime in this furnace, and six months in another (furnace No. 4 of Ougree,) during which period above 15,000 tons of pig-iron have been manufactured by the use of quicklime, have proved in the clearest and most positive manner, not merely the augmentation in the daily production and the diminution in the quantity of coke used, which we did foresee, but also a remarkably ameliorating influence on the whole bearing of the furnace, of which we could have had no previous idea.

Here are the proportions of coke used for the production of 100 of pig iron, during some months of 1849, according as quicklime or limestone was used:—

Limestone.		Quicklime.	
March,	150	July,	142
April,	154½	August,	138
May,	156½	September,	132
June,	151½	October,	139
		November,	142
Average,	153·2	Average,	138·6

Average with limestone,	153·2	100
Ditto with lime,	138·6	90·4
Difference,	14·6	9·6

It may thus be seen that the economy is 9·6 per cent. of the coke employed—figure which corresponds in a most striking manner with that of 9·74, to which we had already arrived by calculation. Rarely have we seen provisions founded on purely theoretical considerations so fully confirmed by the practical results.

At the commencement of 1850, two new furnaces were put in blast at Ougree, the existing kilns being insufficient to supply with lime more than one furnace, and the managers of the works, considering the experience of the last six months as putting the advantage of the use of lime beyond a doubt, asked of the board of directors of the company the authority to erect new lime-kilns, so as to be enabled to supply with lime the three furnaces; but the directors were of opinion that the experiments already made, did not suffice to prove in general the advantage of the use of lime—the favorable result obtained might have been produced by an excellent state of the only blast furnace where the experiment had been tried, and that, perhaps, independently of the use of lime. For the purpose of deciding this question, quicklime was used instead of limestone in furnace No. 4, which had during several months been working in a regular manner, using limestone as a flux; the result was immediate, and very soon a similar diminution in the consumption of coke, augmentation in the daily production, and general good working were observed, as in furnace No. 3.

The accompanying table shows the quantity of coke for 100 of iron, and the production during 28 days for six months of 1850—first, for furnace No. 1, using limestone as a flux; second, for No. 3, using lime; and third, for No. 4, using limestone during three months, and lime during three months. All the furnaces being built after precisely the same model, using the same ores, and producing white or mottled pig-iron by cold blast.

	Coke for 100 Pig-Iron.			Production during 28 days.		
Date,	No. 1.	No. 3.	No. 4.	No. 1.	No. 3.	No. 4.
1850.	Limestone.	Lime.	Limestone.	Limestone.	Lime.	Limestone.
April,	165	145	163	*Tons* 436	601	459
May,	165	147	159	447	582	461
June,	160	147½	164	477	588	488
			Lime.			Lime.
July,	161	146½	149¾	462	555	537
August,	158¾	145	146	465	536	552
September,	153	147⅜	146	477	577	600
Average,	160½	146½	—	461	573	—
Average, April to June—Limestone			162			*Tons* 469 6 *c.*
Ditto July to Sept.—Lime.			147¼			463 0

It appears, by this table, that the quantity of coke consumed is diminished 14 to 15¼ per 100 of iron, and the production in a given time is increased by 22 to 24 per cent.

Although, as a flux, lime must necessarily come to a higher price than its carbonate, yet by its use is the cost of pig-iron very much diminished, and the profits are multiplied, on account of the increased production. We do not consider ourselves authorized to furnish here details of the cost price; but we can affirm, with confidence, that the increase of annual profit secured by this innovation is from 25,000 fr. to 30,000 fr.

Hitherto the opinion of metallurgists has been rather unfavorable than otherwise to the use of lime: Karsten, and after him other writers, establishes the existence of this prejudice, without being able to assign for it a sufficiently plausible reason. M. Valerius (*traité de la fabrication de la fonte*) says, "It is said that the use of lime causes the production of scoriæ rich in iron, white cast iron, &c.; and to explain this bad effect, it is remarked that the calcination of the limestone in the blast furnace produces a very considerable diminution in the temperature, which prevents the ore from arriving too soon—that is, before the oxide of iron is reduced into a region of the furnace where the heat is sufficiently great to allow of the action of the oxide of iron upon the silica." Such a reason appears to us very ill founded; the sole effect of the lowering the temperature will be to allow the ores to arrive imperfectly reduced to a zone of fusion, just as we every day have the opportunity of observing when the ores are wet. The effect of the absorption of heat caused by this moisture is the production of black slags, white pig iron, &c., precisely the contrary of what it should be if M. Valerius's reasoning were exact; but common sense alone suffices to show that a constant cause of cooling in the furnace cannot possibly be advantageous. M. Ebelmen, in his interesting researches on the reduction of iron ore in blast furnaces, observed the considerable cooling effect of the carbonic acid, and the retardation which it causes in the reduction of the ores; yet he did not remark the conversion of the carbonic acid from the limestone into oxide of carbon. The following figures are taken from analyses made by M. Ebelmen, of a calcareous ore which had remained for some time at different depths in the blast furnace:—

	Original ore.	At 8 feet.	13 feet.	15 feet.	17 feet.
Carbonate of lime	36·8	41	40·6	26·6	—
Quicklime,	—	—	—	4·	37·4
Peroxide of iron,	36·2	37	27·8	24·1	—
Protoxide of iron,	—	traces	12·7	17·5	30·2
Metallic iron,	—	—	—	—	10

The height of the furnace was 27 feet; at 15 feet the carbonate of lime had scarcely undergone a commencement of decomposition. M. Ebelmen adds the following remarks—"It appears to me that the cause of the very sudden variation in the rapidity of reduction of the ores must be attributed to the disengagement of carbonic acid from the limestone. It may be remarked that, in the third experiment, the ore has lost a small portion of its carbonic acid, and in the fourth the whole of the lime is in the caustic state—thus the disengagement of the carbonic acid coincides in a striking manner with a sudden variation in the temperature of the furnace, and in the rapidity with which the ores are reduced. There is nothing surprising in this, as Bischoff's experiments have proved that carbonic acid absorbs a large proportion of latent heat while passing from the solid to the gaseous state. The gases which pass through the furnace must, in traversing the zone where the calcination of the limestone takes place, lose a portion of their sensible heat, which becomes latent, while their reductive power is diminished, either on account of the lowered temperature, or because of the considerable admixture of carbonic acid.

In conclusion, we are, as far as we are aware, the first who have succeeded in substituting with success and economy lime for its carbonate

in blast furnaces. The Ougree Company, now fully convinced of the immense advantages derivable from the use of lime, is occupied with the construction of kilns heated by the blast furnace gases.

Liege, December 21.

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On the Use of Caustic Lime, instead of Limestone, in Blast Furnaces. By G. Montefiore Levi, and Dr Emil Schmidt.*

In estimating the profits realized by the use of lime instead of limestone in blast furnaces, in our paper in the *Mining Journal* of the 4th Jan., we have stated that the actual increase of profits secured by this innovation is from 25,000 fr. to 30,000 fr. (1000*l.* to 1200*l.*) per annum. We omitted to add that this increase of profit was for one blast furnace only—that on the present working at Ougrée being above 3000*l.* a year. Since our paper was written, lime has been employed in another large coke furnace, and immediately the daily production rose from 17½ to above 20 tons, the consumption of coke being very much diminished. We shall be happy to furnish any further information, if requisite, to such of your readers as may wish to apply this innovation; every one is at perfect liberty to do so—the use of lime in lieu of limestone not being a patented invention.

Ougree, Jan. 12.

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On the Conduction of Heat in Blast Furnaces; by Francis C. Knowles.†

Sir,—In your last number, I read an interesting article on the employment of quicklime as a flux in blast furnaces. I have long advocated this useful "reform;" but the suggestion was called "theoretical," which, with Prof. Karsten's unsupported dictum, was considered as decisive; but the "theory" is now a matter of fact. This improvement has another practical recommendation not noticed—namely, that the cementation of the ore in quicklime will take up its sulphur, if any, which limestone cannot do. The experiments of Prof. Playfair and Bunsen, ‡ prove that the *whole of the oxygen of the blast* passes into carbonic oxide at or near the tuyères. If this be fact, it follows incontestably that the whole of the heat in the higher regions of the furnace, is *heat produced by conduction from below and from the heated gases in their passage, and not by combustion above.* It is like the heat given out by one end of a bar of iron, while the other end is in the fire. This is a most important fact in our consideration of the working of blast furnaces. It points out to us that *all* causes tending to affect the *uniformity* of the temperature at any given point within the furnace—such as ore or fuel containing moisture, ore containing carbonic acid, raw limestone, &c.—should be sedulously avoided. Even the use of raw coal may, in this point of view, be of doubtful utility. But there cannot be a doubt that the daily introduction of several tons of solid carbonic acid, in masses scattered at irregular intervals through the furnace, must greatly derange the *uniformity* of its temperature, and, therefore, that of its working, while the gas is taking up its latent heat in passing into the æriform state. It may, at first sight, appear that the solid oxygen

* From the London Mining Journal, No. 805. † Ibid. No. 804.

‡ Reports of British Association. Cambridge, 1836.

of the ore should produce similar effects; but here a sort of compensation takes place (as appears from Profs. Playfair and Bunsen's report) through the combination of the carbon, or carbonic oxide, with this oxygen, which combination evolves heat enough to become the required latent heat of the resulting gas. This fact of conduction, assuming it to be established, will enable us to test the process of "tapping" the furnace (it matters not how,) in order to obtain its gases for fuel. These gases are driven up from below intensely heated; and they heat in their passage the whole mass of materials in the furnace up to its throat. If they be withdrawn from a point even a few feet below this, their heat is lost *exactly when it is of most importance to obtain its full effect*—viz., heating the fresh and cold charges, and driving off moisture, &c., from the ores and the fuel. This consideration would seem to be decisive; and, therefore, if we are to use the furnace gases, it should be after they have performed their function and quitted the furnace. It remains to be seen whether this fact of conduction, if sufficiently established, will not lead to other important conclusions as to the form of the interior of the furnace, the mode of charging it, &c.

London, January 10.

On the Use of Caustic Lime, instead of Limestone, in Blast Furnaces. By Evan Hopkins.*

It is to be hoped that the old imperfect routine of some of our large manufactories, especially in the production of iron, will be gradually corrected by the diffusion of the chemical and mechanical principles on which the several operations are established. Some time ago you published a short abstract from one of my reports *On the Furnaces and Mills of Prussia, and other Iron Districts on the Continent*, which showed the simplicity and superiority of some of their works, as compared to many of ours, in addition to the operators evincing superior intelligence in the practice and principles of making iron.

The quality of the materials employed, the blast furnaces and mills, together with the quality of the produce, were duly dwelt on in detail, and the mode adopted for preventing the splitting and bruising of the surface of the rails taking place, which is too often the case with many of our rails, for the want of such precaution in the piles.

With respect to the present question, on the use of caustic lime, instead of limestone, in blast furnaces, it is evident that there is a considerable advantage in it. Firstly, it acts as a test on the quality of the flux. It ought to be pure limestone; but it often happens that the nearest calcareous formation, or quarry, is impregnated with the silicate of calcium, magnesium, and other impurities. Consequently, when such limestone is thrown into the furnace in a raw state, a portion passes through unchanged, and comes out at the periods of cleaning the hearth, mixed with the slag or scoriæ. This I have frequently witnessed in large furnaces.—Secondly, the previous calcination saves a large amount of fuel, and makes the latter more effective in the smelting process.—Lastly, it purifies the coke more perfectly. This may be easily proved by dipping impure coke into a

* From the London Mining Journal, No. 806.

solution of lime, and employing it for smelting. The pyrites which may exist in the coke is decomposed into a sulphate of lime, and the iron combined with the carbon—in short, a much more perfect decomposition takes place amongst the materials. I am very glad to see the subject taken up, as it must tend to effect some good by introducing economy of materials, simpler arrangements, and a more perfect process in our iron manufactories.

For the want of good early training in the general principles of our mines and smelting establishments amongst the operatives, England is suffering in the extraction and conversion of her internal resources, as well as in the available capital. There is almost an impassable gulf between the practical man who has been bred and reared in the mines, smelting-works, or work-shop, and the man of science who has been educated in the academy or university. The uneducated practical man, when once he has acquired a certain routine, is a valuable and indispensable instrument to the welfare of an establishment; and such men, under the guidance of prudent and intelligent men of science, lead to improvements and beneficial results. But should the person placed in charge be filled with doctrines founded on assumptions, and who never descended to the mechanical drudgery of experimental inquiry to acquire practical knowledge, and who may regard the mere practical man as a person beneath his notice, he cannot but soon bring ruin on an establishment.

Again, we have another drawback, which, to my knowledge, has been the cause of ruin to some establishments carried on by Englishmen—viz.: the appointment of persons to take charge who may be very good accountants, and plausible writers, but possessing little knowledge in the management of men, or of the work which may be placed under their superintendence. It is true that, in a well-regulated concern, a steady man of business is preferable to a loose irregular manager, if he exercises his judgment in the operations with discretion; but if, on the contrary, he becomes opinionated, keeps on the routine by elevating the ordinary practical men above their proper position, and encourages them in old contracted notions, in opposition to all improvements which do not emanate from himself, and working in the dark by the rule of thumb without plans or principles, it is clearly evident that the mere accident of natural favorable circumstances alone can render such proceedings permanently successful. These are of every day occurrence abroad, as well as in the United Kingdom; and can only be removed by the diffusion of useful knowledge, and the elucidation of the general principles connected with our national industry.

Austinfriars, Jan. 28.

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*Report on a New Combustible Substance, Discovered in Russia.**

A combustible substance, named *Pungernite*, by M. Bulgarine, has been found in the Silurian formation, between Rana-Pungern and Gross-Pungern, on the road from Dorpat to Narva, in Esthonia, in the form of a yellowish brown laminated layer, speckled with white, very light, and

* From the London Mining Journal, No. 801.

about as hard as coal; it burns freely and brightly, giving off a great quantity of soot. According to M. Petzold, its constituents are :—

Organic matter, . .	65·5	Carbonate of lime, . .	17·0
Silica, ...	13·6	Carbonate of magnesia, .	0·2
Oxide of iron and alumina, .	2·3	Water, . . .	1.2=99·8

It yields much less carburetted hydrogen gas than coal does—the proportion being nearly 1 to 5; and the amount of heat derivable from it is also less than that obtained from coal, but rather greater than that yielded by charcoal.—*Proc. Geol. Soc., Dec.* 18.

For the Journal of the Franklin Institute.

Description of a Calculating Machine, Invented by J. W. Nystrom, *Philadelphia.* (*See patent, p.* 241.)

This Calculating Machine, (plate IV,) consists of a round plate of brass, or any other material, and two arms A and B, extending from the centre C, to the periphery. In the outer end of each arm is a screw *e*, for the purpose of fastening the arms in any particular place. On the plate are four figure circles *a*, *b*, *c*, and *d*, of which the outer one *a*, contains the numbers for multiplication and division. The large figures in the same circle *a*, represent the first figure, and the small figures the second; the third figure will be found on the arms, and the fourth between the figures on the arms.

Example. To set the arm B, on 1449.—Then 1 being the first figure, set the arm B on the large 1, on the circle *a*, move the arm B to the small figure 4, which is the second figure; move B until the line 4 crosses the figure 4 on the arm B, which is the third figure, and between 4 and 5 is the fourth figure, when the same line 4 crosses the ninth dividing. In that position of the arm, B is set on 1449. The number in circle *b* shows the decimal part of the logarithm (mantissa) for the number in circle *a*.

Example. Log. 1449=3·1610.—The circle *a* shows the length of the sinus for an angle numbered in circle *c*, and also *a* shows the length of the cosinus for the angle numbered in the circle *d*. The numbers in circles *c* and *d* show the angle in degrees, and the figures on the arms between *c* and *d* shows the minutes. The numbers in circle *b* show the logarithms for all the trigonometrical lines on circle *a*.

General Rule for Multiplication.

Rule 1. Set the arm A on one of the factors, (circle *a*,) set the arm B on 1, fasten the arms with the screw C, move the arms until the arm B comes to the second factor; the arm A will show the product.

Example 1. Multiply 6 by 8, or 6 × 8.—Set the arm A on 6, and B to 1, fasten the arms with the screw C, move the arms until B comes to 8; the arm A will show 48 the product. If more than two factors are to be multiplied together, consider the product of the two factors as the first factor, and proceed with multiplication as before described.

Example 2. 7 × 12 × 15.—Set the arm A on 7, B on 1, fasten the arms with the screw C, move them until B comes to 12, fasten the arm A with

the screw *e*, loose the arm B and set it on 1, fasten the screw C, loose *e*, move the arms until B comes to 15; the arm A will show the product= 1260. If there are any more factors, consider the last product as the first factor, and go on as before.

General Rule for Division.

Rule 2. Set the arm A on the dividend (circle *a*) and B on the divisor, fasten the arms with the screw C, and move them until B comes to 1; the arm A will show the quotient.

Example 1. 36 divided by 12, or 36 : 12.—Set A on 36, B on 12, fasten the arms with C, move the arms until B comes to 1; then A will show the quotient. If any number is to be divided by more than one divisor, consider the quotient of the first divisor and dividend as a dividend, and divide by the second divisor.

Example 2. $\frac{3696}{4\times12}$.—Set A on 3696, and B on 4, fasten C, move the arms until B comes to 1, fasten A°, loose B with C, and put B on 12, fasten C, and move the arms until B comes to 1; then A will show the quotient =77. If any dividend contains more than one factor, and also more than one divisor, multiply all the factors in the dividend after Rule 1, and divide with the divisors after Rule 2.

General Rule for Proportion.

Rule 3. Set A on the first term, B on the second, fasten A and B with C, move the arms until A comes to the third term; then B will show the fourth term. If the fourth term is known, set B to the fourth term; then A will show the third term.

Example 1. 3 : 9=6 : 18.—Set A on 3, B on 9, fasten C, move the arms until A come to 6; then B will show the fourth term=18.

Example 2. If a car run 552 miles on a railroad in 24 hours, how far will it run in 13 hours?

552 : 24= x : 13.—That is, set A on 552, and B on 24, fasten C, move the arms until B come to 13, the arm A will show the answer=299 miles.

Example 3. If 248 men in 5 days of 11 hours a day each, can dig a trench of 230 yards long, 3 yards wide, and 2 yards deep, in how many days of 9 hours each, will 24 men dig a trench 420 yards long, 5 yards wide, and 3 yards deep?

$$\begin{matrix}248\\5\\11\end{matrix} : \begin{matrix}24\\x\\9\end{matrix} = \begin{matrix}230\\3\\2\end{matrix} : \begin{matrix}420\\5\\3\end{matrix} \qquad x = \frac{248\times5\times11\times420\times5\times3}{24\times9\times230\times3\times2}$$

Set A on 248, B on 1, fasten C, move A and B, until B comes to 5, fasten A°, loose C, set B on 1, fasten C, move A and B until B comes to 11, fasten A°, loose C, set B on 1, fasten C, move A and B until B comes to 420, fasten A°, loose C, set B on 1, fasten C, move A and B until B comes to 5, fasten A°, loose C, set B on 1, fasten C, loose A°, move A and B until B comes to 3, fasten A°, loose C, set B on 24, fasten C, loose A°, move A and B until B comes to 1, fasten A°, loose C, set B on 9, loose A°, move A and B until B comes to 1, fasten A°, loose C, set B on

230, fasten C, loose A*, move A and B until B comes to 1, fasten A*, loose C, set B on 3, fasten C, move A and B until B comes to 1, fasten A*, loose C, set B on 2, fasten C, loose A*, move A and B until B comes to 1; then A will show the answer $= 288\frac{3}{10}$ days.

This calculation is nothing more or less than an addition and subtraction of the logarithm of the factors, though it is not necessary to notice the logarithm. But, when the number of figures in the result is uncertain, a correct account must be kept of the indices of the factors. For that purpose there is a small hand on the top of the screw C, which is to be moved by hand for each operation; for multiplication add the indices, and for each time the arm A moves over 1, add one to the index, (because the sum of the mantissæ of the factors is more than 1.) For division, subtract the index for the divisor from the index for the dividend; and for each time the arm A moves over 1, subtract one from the index, (because the difference between the divisor and dividends mantissæ is less than one.) If the index is negative, the result must be a corresponding decimal fraction.

Example 4. What is the power of a steam engine, (condenser)?

Two cylinders, diameter of each,	42 inches,
Stroke of piston,	27 "
Pressure in the boiler per square inch,	30 lbs.,
Cut off $\frac{1}{3}$ of the stroke, the mean pressure will be per square inch,	20 "
Vacuum per square inch,	10 "
Making turns per minute,	79
Coefficient for all the frictions and pumps,	$=0{\cdot}3333$

$$\text{Horse power} = \frac{42^2 \times 0{\cdot}785 \times 30 \times 4 \times 2{\cdot}25 \times 79 \times 0{\cdot}666}{33000} = 600.$$

To Reduce a Vulgar Fraction to a Decimal, or to another Vulgar Fraction.

Rule 4. Set the arm A on the numerator, and B on the denominator, fasten the arms with C, and move A and B until B comes to 1; then A will show the decimal.

Example 1. Reduce $\frac{3}{4}$ to a decimal fraction.—Set A on 3, B on 4, fasten C, move the arms until B comes to 1; then A will show the decimal fraction, $= 0{\cdot}75$.

Example 2. Reduce $\frac{13}{19}$ to decimals.—Set A on 13, and B on 19, fasten C, move the arms until B comes to 1; then A shows the decimal fraction, $= 0{\cdot}6842$.

Example 3. Reduce $\frac{2}{5}$ to 70ths.—Set the arm A on 2, B on 5, fasten C, move the arms until B comes to 70; then A shows 28, that is, $\frac{28}{70}$. If the arms be moved into any position, the numbers within the arms will always be in proportion of 2 : 5.

Example 4. Multiply 24 by $\frac{19}{32}$.—Set the arm A on 24, B on 32, fasten C, move the arms until B comes to 19; then A shows the result, $= 14{\cdot}25$. Subtracting roots on this calculating machine is precisely the same as subtracting roots by logarithms, and requires the same accuracy in the dividing the indices and mantissæ, for the number of which the root is to be subtracted.

Rule for Subtracting Roots.

Rule 5. Divide the logarithm of the number (of which the root is to be subtracted) by the index of the root, the corresponding number on the circle *a* is the root. That is to say, the index is kept with the small hand, the mantissa on the circle *b*, and the numbers on circle *a*.

Example 1. $\sqrt{3694}=60{\cdot}78$.—Set the arm A on 3694, fasten A*, the index kept with the hand=3, mantissa on circle *b* is 0·565, that is log. =3·565, $\frac{3{\cdot}565}{2}=1{\cdot}7837$. Set the arm B on 7837 on circle *b*, the corresponding number on circle *a* is the root=60·78.

$$\sqrt[3]{26853.}\ \frac{\log.}{3}=\frac{4{\cdot}4289}{3}=1{\cdot}4796=\log.\ 3017$$

$$\sqrt[5]{2369000.}\ \frac{\log.}{5}=\frac{6{\cdot}3765}{5}=1{\cdot}2549=\log.\ 17{\cdot}99$$

$$\sqrt[9]{39249000.}\ \frac{\log.}{9}=\frac{7{\cdot}5937}{9}=0{\cdot}84373=\log.\ 6{\cdot}978$$

To Find the Mean Proportional of Two Numbers.

Example. What is the mean proportional of 4 and 9? $4:x=x:9$ $x=\sqrt{4\times9}=6$.—Set A on 4, B on 1, fasten C, move the arms until B comes to 9, fasten A*, loose C. Mantissa on the arm A=0·5568, index =1, log.=1·5568. Set the arm B on mantissa 0·5568 on circle *b*, the corresponding number on circle *a* is the mean proportional=6.

Trigonometrical Calculations.

The trigonometrical calculations are to be computed on the circles *c* and *d*, (see page 262.)

Example 1. What is the angle with the horizontal, of an inclined plane 24 feet in length and 8 feet in height? Sin. $A=\frac{8}{24}$, then A=19° 28′. Set the arm A on 8, B on 24, fasten C, move the arms until B comes to 1; then the angle A=19° 28′ shows on circle *c*.

Example 2. How long must an inclined plane be to form an angle with the horizontal 38° 49′ and 16 feet in height? Length=$\frac{16}{\text{sin. } 38°\ 49'}$= 25·55 feet; set the arm A on 16, B on sin. 38° 49′, fasten C, move the arms until B comes to 1; then A shows the height=25 $\frac{55}{100}$ feet.

Example 3. What is the height of a church steeple, when a distance of 53½ yards is measured from its centre horizontally to an angle of 57° 29′ to the top? Height=53½×3× tang. 57° 29′=53½×3×$\frac{\text{sin.}}{\text{cos.}}$57° 29′. Set A on 53·5, B on 1, fasten C, move the arms until B comes to 3, fasten A*, loose C, set B on cos. 57° 29′, fasten C, loose A*, move the arms until B comes to sin. 57° 29′; then the arm A shows the height= 252 feet.

To Find the Tangent for an Angle A.

Rule. Set A on sin. A, and B on cos. A, fasten C, move the arms until

B comes to 1; then A shows the length of the tangent on circle *a*.

Example. Tang. 55° 35′ = $\frac{\text{sin.}}{\text{cos.}}$ 55° 35′ = 1·4635.—Set A on sin. 55° 35′, and B on cos. 55° 35′, fasten C, and move the arms until B comes to 1; then A shows the length of the tangent = 1·463 on circle *a*.

To Find the Cotangent.

Example. Cotangent = $\frac{\text{cos.}}{\text{sin.}}$. cotang. 55° 35′ = $\frac{\text{cos.}}{\text{sin.}}$ 55° 35′ = 0·685. Set A on cos. 55° 35′, B on sin. 55° 35′, fasten C, move the arms until B comes to 1; then A shows the length of the cotangent = 0·685 on circle *a*.

To Find the Secant.

Example. Secant = $\frac{1}{\text{cos.}} = \frac{1}{\text{cos. } 55° \ 35'}$.—Set A on 1, B on cos. 55° 35′, fasten C, move the arms until B comes to 1; then A shows the length of the secant on circle *a* = 1·7725.

To Find the Cosecant.

Example 1. Cosecant = $\frac{1}{\text{sin.}} = \frac{1}{\text{sin. } 55° \ 35'}$.—Set A on 1, B on sin. 55° 35′, fasten C, move the arms until B comes to 1; then A shows the length of the cosecant = 1·212.

Example 2. In a triangle are measured one side *a* = 92 feet, an angle A = 31° 16′, angle B = 61° 3′. How long is the side *b*?

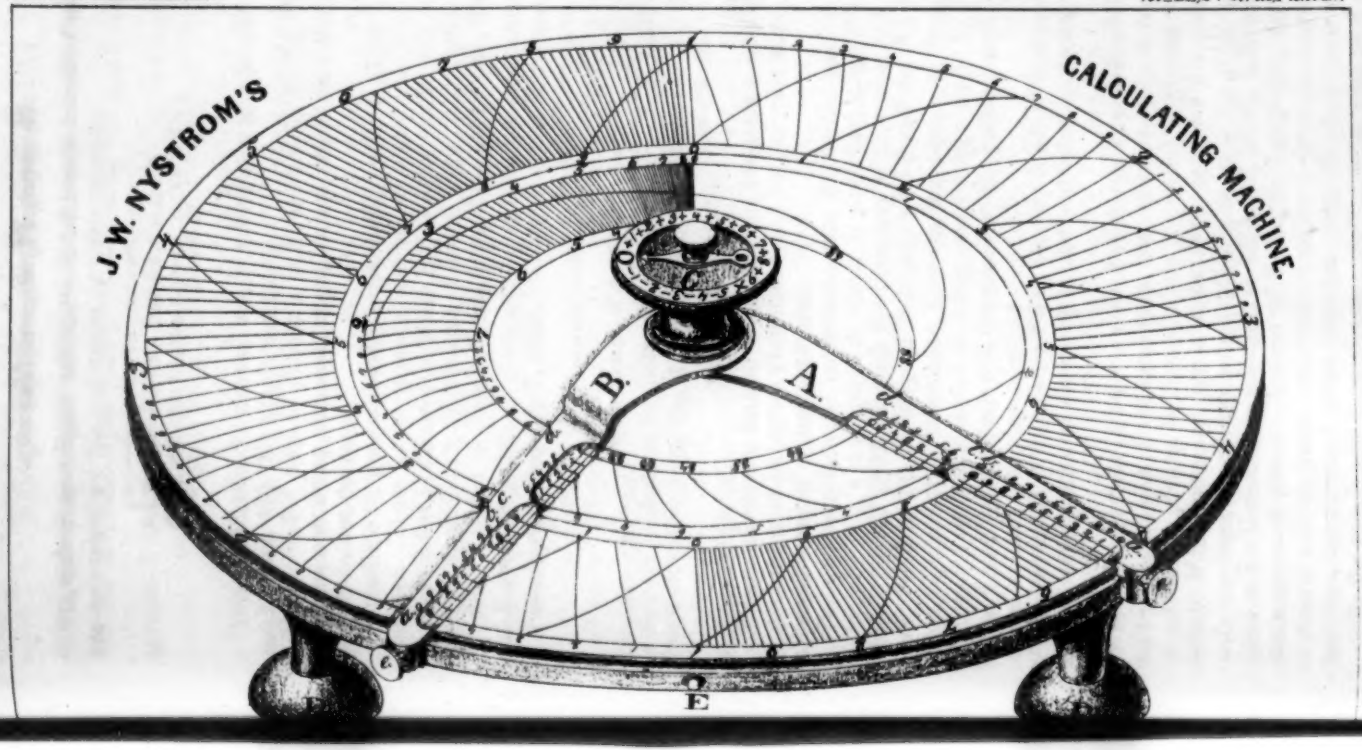
$$b = \frac{92 \times \text{sin. } 61° \ 3'}{\text{sin. } 31° \ 16'} = 155.$$

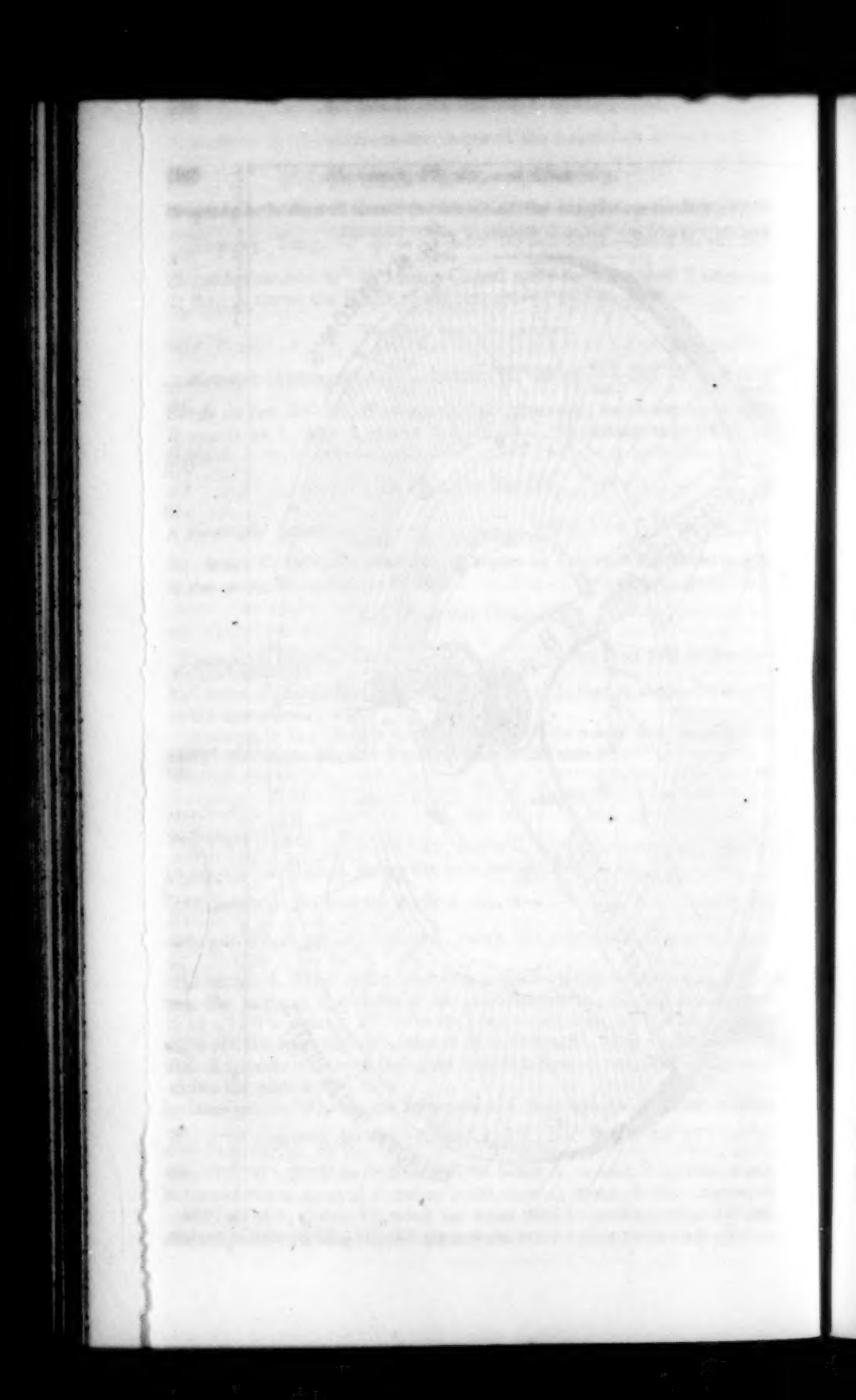
Set A on 92, B on sin. 31° 16′, fasten C, move the arms until B comes to sin. 61° 3′; then A shows the side *b* = 155 feet on circle *a*.

Example 3. To find the angle A, sin. A = $\frac{92 \times \text{sin. } 61° \ 3'}{155} = 31° \ 16'$. Set A on 92, B on 155, fasten C, move the arms until B comes to sin. 61° 3′; then A shows 31° 16.

Example 4. What is the pitch of a propeller 11 feet 6 inches in diameter, the angle of the blades at the extremity being 53° 35′? Pitch = 3·14 × 11·5 × cotang. 53° 35′ = 26·7 feet.—Set A on 3·14, B on 1, fasten C, move the arms until B comes to 11·5, fasten A*, loose C, set B on sin. 53° 35′, fasten C, move the arms until B comes to cos. 53° 35′; then A shows the pitch = 26·7 feet.

Example 5. What is the declination of the earth on the 14th of May, that is, 38 days from the 21st of June? Cos. $\left(\frac{360}{365}. 38\right) \times 23° \ 27'$, that is, cos. 37° 30′ × 23·45 = 18·55 = 18° 33′.—Set A on 360, B on 365, fasten C, move the arms until B comes to 38, then A shows 37·5°. Set A on 23·45, B on 1, fasten C, move the arms until B comes to cos. 37° 30; then A shows 18·55 = 18° 33′ the answer.


J. W. NYSTROM'S
CALCULATING MACHINE.
B.
A.
E



The following example will show that the most complicated questions can be worked on this instrument in a few minutes:

$$\sqrt[5]{\frac{36{\cdot}97^{\frac{1}{3}}\,(98{\cdot}5-12)^2.63\sqrt{156}}{\sqrt[4]{97{\cdot}6\,(39{\cdot}95-15)^2\sqrt{927{\cdot}6^3}}}} = 2{\cdot}095.$$

This specification is deemed amply sufficient to give an idea of what can be done with this simple instrument.

It is intended soon to publish a book to accompany the Calculating Machine, containing numerous examples and directions that will enable persons to use the same.

A machine for general business calculation, will be about 9 inches in diameter. Those for astronomical and the more particular branches, will be about 2 feet in diameter, and the engraving of course will vary. Another for approximate calculations, intended to put in pocket-books, will be about 3 inches in diameter, and printed on paper; also, the arms A and B made of paper.

Philadelphia, February 7, 1851.

For the Journal of the Franklin Institute.

A Series of Lectures on the Telegraph, delivered before the Franklin Institute.

By Dr. L. Turnbull. 1850–51.

Continued from page 196.

Before considering the individual galvanic telegraphs, it will be proper to state the most important phenomena and laws of galvanism; also, the principal forms of voltaic apparatus.

The first instrument of importance, was the voltaic pile of Professor Volta, of Pavia, a description of which is published in the *Philosophical Transactions* of 1800; although the discovery of galvanism is due to Galvani, Professor of Anatomy at Bologna, who found that by forming a chain of conducting substances, between the outside of the muscles of the leg and the crural nerve of a frog, convulsions might be produced. Galvani previously entertained the idea, that the contractions of the muscles of animals were dependent on electricity.

The invention of the pile by Volta, was the result of profound thought on the development of electricity at the surface of contact of different metals.

The galvanic pile of Volta consisted of an equal number of silver coins and pieces of zinc of the same form, with circular disks of card soaked in salt water; of these he formed a pile or column by placing them alternately. If the uppermost disk of metal, either copper or silver, be touched with the finger, previously wetted, while a finger of the other hand is applied to the lowest disk, a distinct shock is felt, which is increased with the number of plates. Instead of the moist conductor, we now use liquids of various kinds, and electricians have devised various forms of batteries, but all based on the important principle discovered by Volta.

"By the voltaic pile, I mean such apparatus, or arrangement of metals,

as contain water, brine, acid, or other aqueous solutions or decomposable substances between their plates; decomposition is an essential chemical part of every voltaic battery."—(*Faraday's Researches.*)

It was Volta who removed our doubtful knowledge. "Such knowledge is the early morning light of every advancing science, and is essential to its development; but the man who is engaged in dispelling that which is deceptive in it, and revealing more clearly that which is true, is as useful in his place, and as necessary to the general progress of science, as he who first broke through the intellectual darkness, and opened a path into knowledge before unknown."—(*Ibid.*)

According to Professor Faraday, the supply of electricity is due to chemical power in the voltaic pile, metallic contact not being necessary for the production of the voltaic current; and further, that electricity is only another mode of the exertion of pure unmixed chemical forces. It is proportional in its intensities to the intensities of the affinities concerned in its production, and its quantity to the quantity of matter which has been chemically active during its evolution. It is the union of oxygen of the water which determines the current; and though the acid is essential to the removal of the oxide so formed, in order that another portion of zinc may act on another portion of water, it does not by combination with that oxide produce any sensible portion of the circulating electrical current; for the quantity of electricity is dependent on the quantity of zinc oxidized, and is scarcely, if at all, affected by the use of either strong or weak acid. Galvanic differs from frictional electricity in its low degree of intensity, the larger amount set in motion, the greater constancy, more perpetual reproduction, less tendency to escape, and better conduction along metallic substances without being dissipated. The unequal character of all the batteries previous to the one introduced by the late Prof. Daniell, of King's College, London, was a serious obstacle to telegraphic operations; they are familiar to most persons who have taken any interest in this important matter, and I will therefore omit them.

Prof. Daniell was the first to invent a battery capable of constant and steady action, and thus overcame the defects of those previously in use. The defects which cause the electromotive action to subside rapidly, and soon to cease altogether, are: 1st, The sulphuric acid becomes saturated with the oxide of zinc. 2d, The hydrogen adheres to the surface of the metals, and thus prevents their perfect contact with the water. 3d, By the chemical action of the battery, the zinc, contained in the sulphate of zinc which is formed, is reduced to the metallic state at the surface of the copper, and deposited upon it in the form of a crust, where it acts locally and impairs the conducting power. 4th, Electricity is carried off and dissipated by the escaping hydrogen. 5th, Impurities on the surface of the zinc form small circuits, by which the electricity is conducted back into it, without going through the fluid to the copper, and then returning by metallic connexion.

The adhesion of hydrogen to the zinc plate, does not take place when that metal is pure or amalgamated with mercury. Prof. Daniell, therefore, employs a cylindrical rod of zinc, amalgamated with mercury, instead of a plate of the common and impure metal. The amalgamation has also the effect of preventing the small local electric circuits, by covering up the

impurities which exist on its surface. This was first introduced by Sturgeon. But the peculiar and most vauable feature of this battery is the use of a porous partition, which may be formed of animal membrane, earthenware, plaster of Paris, paper, or any similar substance. This divides the vessels containing the metals into two cells, one of which, the zinc cell, is filled with dilute sulphuric acid, in proportion of ten the parts water to one of acid, and the other with an acid solution of sulphate of copper. The partition freely transmits the electrical current, but prevents the passage of the sulphate of zinc to the copper plate, and thus remedies the third of the above mentioned defects. The sulphate of copper is decomposed into sulphuric acid and protoxide of copper. The sulphuric acid passes through the partition into the zinc cell, there to act upon the oxide of zinc, while the oxide of copper is again decomposed into oxygen and metallic copper. The oxygen unites with the nascent hydrogen formed in the oxidation of the zinc to form water, and the metallic copper is deposited on the copper plate, keeping the plate constantly bright, and thus making it a better conductor. The hydrogen being consumed in the formation of water, it cannot interfere with the action of the conducting plate, nor convey away electricity. A little frame is fitted to the top of the cell, in which crystals of sulphate of copper are placed, in order that the strength of the solution may remain unimpaired.

Another form of battery, proposed by Prof. Grove, of London, is an improvement upon Prof. Daniell's, in respect to amount of force generated in a small space, and has been adopted in most of the telegraphic offices of this country. A platinum plate is substituted for the copper one of Prof. Daniell, and instead of sulphate of copper, strong nitric acid is used, which furnishes oxygen to unite with the hydrogen. The oxygen in nitric acid is held by very slight affinity, and many chemical substances reduce the nitric acid to hypo-nitrous and nitrous acid, which contains two or three equivalents less. The increase of power in Grove's battery over Daniell's battery, for the same amount of zinc dissolved, is equal to the difference of affinity between oxygen for nitrous acid and oxygen for zinc. The force of Grove's battery is, therefore, equal to the affinity of oxygen for zinc, minus the affinity of oxygen for nitrous acid. The energy of a galvanic arrangement depends to some extent upon the difference in the affinity for oxygen of the metals employed, which in the case of platinum and zinc, is at a maximum, zinc being most readily oxydized, and platinum least so. The zinc plate, as in Daniell's, is amalgamated and surrounded by sulphuric acid, diluted with eight parts of water, while the nitric acid is placed in the platinum cell. A Grove battery exposing a surface of zinc equal to twenty square inches, was found by its magnetizing power, to afford a current of greater quantity than a Daniell battery exposing 210 inches of zinc. The intensity of the current is also considered three times as great as Daniell's, and is remarkable for its constancy. The escape of nitrous acid, red fumes from this battery, render it disagreeable and unsafe to a careless experimenter. They are irrespirable, and injurious to nice apparatus which may be exposed to them. By placing a metallic covering (protected from the acid fumes) over the battery, and allowing the gases to escape through an orifice stuffed with

cotton, wet with a little alcohol, these may be to some extent neutralized. The intensity of the current depends on the chemical affinities which are concerned, and on this account there is a gain in Grove's battery over Daniell's. Prof. Callan, of Maynooth College, Ireland, has invented a galvanic battery, cheap in its construction and use, yet powerful. He substitutes cast iron for the outer copper cell, and a flat piece of zinc for the inner one, with equal parts of nitric and sulphuric acids for the outer cell, and a mixture of two parts of nitric acid, five of sulphuric acid, and forty-five of water for the inner one.

The effects of the galvanic current on the nerves and muscles of animals, are essentially the same as those produced by frictional electricity, modified, however, in some degree, by the continuous action of it. They are also characterized by the presence of some chemical influence, which excites the organs of taste and sight in a remarkable manner. Very small batteries are adequate to excite the organs of taste and sight, but a large apparatus is needed to produce any perceptible influence on the sense of touch, so as to cause the muscles of the human body to contract, when it forms part of the circuit. Galvani, in his fundamental experiment, touched the nerves of a dead frog's spine and the muscles of one of his thighs with two different metals, and then forming a circuit by a wire between them, the leg became violently contracted. When the nerves of vision are made to form part of the voltaic connexion, peculiar luminous flashes will appear before the eyes. The excitement of the organ of hearing under similar circumstances is not less interesting, a roaring sound being heard as long as the wires are kept in place. On closely observing the effect of galvanic electricity upon the muscular and nervous system, three distinct stages in the process are readily seen. First, when the circuit is completed, an electric shock is experienced; next, the continued action of the current causes a series of contractions rapidly succeeding each other; and lastly, when the connexion is broken, a less violent shock than before is felt. The shock of a voltaic battery differs from common electricity, as the latter is felt far less deeply, affecting only the outer part of our organs, and being exhausted in a moment. The voltaic shock, on the contrary, penetrates farther into the system, passing along the entire course of the nerves. The influence of the galvanic current on the nervous system, has been successfully applied to the restoration of persons in whom animation was suspended. By means of it, Aldini set in motion the feet of a corpse, caused the eyes to open and shut, and distorted the mouth, cheeks, and the whole of the countenance. Ure, by completing the circuit through the body of a man recently hung, caused the muscles of the face to acquire a frightful activity, so that rage, despair, and anguish, with horrid smiles, were successively depicted on the countenance. —(*Peschell's Elements of Physics.*)

The chemical effects of galvanism are perhaps the most important of all that come under our observation. Prof. Faraday's investigations have recently added most materially to our knowledge on this subject, and it is to him that we are indebted for detecting most of its laws. To produce these effects, the electrical current must be conducted completely through the substance which is to be decomposed; as soon as the circuit is completed, the elements are set in operation, and so continue until the connexion is broken. The bodies to be resolved must be con-

ductors of electricity, and also be in a liquid condition, that their particles may move freely among each other. The circuit may be completed through the fluid, by dipping into it the metallic wires which connect with the poles of the battery. These extremities of the wire are commonly termed *poles*, from an idea that they exert attractive and repulsive energies towards the elements of the decomposing liquid, just as the poles of a magnet act towards iron; and each is farther distinguished by the term positive, and negative, according as it affects an electrometer with positive or negative electricity. Now Prof. Faraday contends, and has proved by experiment, that these poles have not any attractive or repulsive energy, and act simply as a path, or door, to the current; he hence calls them electrodes, from *electron*, ελεκτρον, electricity, and *odos*, οδος, a way. The electrodes are the surfaces, whether of air, water, metal, or any other substance, which serve to convey an electric current into and from the liquid to be decomposed. The surfaces of this liquid which are in immediate contact with the electrodes, and where the elements make their appearance, are termed anode, and cathode, from *ana*, ανα, upwards, and *odos*, οδος, the way in which the sun rises, and *kata*, κατα, downwards, the way in which the sun sets. The anode is where the positive current is supposed to enter, and the cathode where it quits, the decomposing liquid; its direction, when the electrodes are placed east and west, corresponding with that of the positive current, which is thought to circulate on the surface of the earth. To electrolyze a compound is to decompose it by the direct action of galvanism, its name being formed from *electron*, ελεκτρον, and *luo*, λυο, to unloose or set free. An electrolyte is a compound which may be electrolyzed. The elements of an electrolyte are called ions from *ion*, ιον, going, neuter participle of the verb to go. Anions, are the ions, which appear at the anode, and are usually termed the electro-negative ingredients of a compound, such as oxygen, chlorine, and acids; while the electro-positive substances, as hydrogen, metals, alkalies, &c. which appear at the cathode, are cations. Whatever may be thought of the necessity of some of these terms, the words electrode, electrolyze, and electrolyte, are peculiarly appropriate.—(*Faraday's Experimental Researches.*)

Water, the first agent decomposed in this way, was electrolyzed by Messrs. Nicholson and Carlisle, soon after the discovery of the voltaic pile. From its low conducting power, water requires a powerful current for its decomposition, unless it be slightly acidulated. In 1803, Berzelius and Hisinger ascertained the power of the galvanic battery to resolve many other substances into their elements; that these elements observed regular laws in their resolution into more simple form, as oxygen and acids accumulated about the positive pole; while hydrogen, alkaline earths, and metals appeared at the negative one. Sir H. Davy communicated to the Royal Society, his celebrated Lecture on some chemical agencies of Electricity in 1806; and in 1807, he announced the grand discovery of the decomposition of the fixed alkalies. Faraday's masterly productions on this subject were elicited in the period from 1831 to 1840, some of which important results have been mentioned.

It is an interesting matter to obtain a fixed rule or law, by which we can estimate the amount of projectile force needed by a galvanic current

to pass over a certain length of telegraphic wire; though all such rules must be more or less inconclusive, from the number of contingent circumstances on which they depend; still, from experiment and observation, we can obtain those which may be useful in making what are termed rough calculations. To make such a computation, we must on one hand find all the sources which give motive power, and on the other seek those agencies which offer resistance to that power, obtain the sum of each, and then institute a comparison. The power is that electricity of intensity which a single galvanic cell is capable of generating. This multiplied by the number of cells gives us the whole amount of electrical power. The resistance is that obstruction the electricity meets in the conducting metal and the liquid of the cells. Find the amount of obstruction in a single cell; this multiplied by the number of cells affords the total sum of a battery. Then divide the whole sum of power by the total amount of resistance in the conducting wire and liquid of the battery cells, and the quotient will be the effective power of the battery.

The electromotive force of an electric current may be ascertained by the following important law of Ohm, being applicable under all circumstances, referring to all the causes which tend to impede the action of the battery. "It is, that the intensity of an electric current where a battery is in action, is directly as the whole electromotive force in operation, and inversely as the sum of all the impediments to conduction. It may therefore be expressed by a fraction whose numerator is the electromotive force, and its denominator the sum of the resistance of all its parts. Let I be the intensity of the current; E the effective electromotive force in the battery; R its constant retarding influence, and r the variable retarding influence in the connecting wires; then

$$I = \frac{E}{R+r}.$$

If, according to Ohm's formula, we put the intensity of the current in a simple voltaic arrangement whose excited surface is I,

$$1.\quad I = \frac{E}{R+r}.$$

Then the intensity of a current from a battery of n pairs of plates or cups will be,

$$2.\quad I' = \frac{n\,E}{n\,R+r},$$

and in a single voltaic arrangement whose surface is n times greater than I, the resistance to conduction being diminished inversely as the area of its transverse section, the intensity becomes

$$3.\quad I'' = \frac{E}{\frac{R+r}{n}} = \frac{n\,E}{R+nr}."$$

The resistance to an electric current in a conducting wire is in proportion to the length of the wire, and inversely as its sectional area. That is, the longer the wire the greater the resistance, and the larger the wire the less the resistance. If the wire be many miles long, the resistance to the

electrical current varies arithmetically as the wire increases in length geometrically. Arithmetical progression is constant addition, while geometrical progression is constant multiplication, and the ratio would stand thus:

Resistance, 1 : 3 : 5 : 7 : 9 : 11 : 13 : 15, &c.
Length, 1 : 2 : 4 : 8 : 16 : 32 : 64 : 128, &c.

The resistance of the liquid in the cells is in direct proportion to the amount and thickness of that fluid, and in the inverse proportion to its conductibility. Or the greater the thickness of the fluid, the more resistance it will oppose to the galvanic current; while, on the other hand, the greater the conducting power of the fluid, the less obstruction is presented.

Thus it will be seen that the data for such an estimate are numerous, and require much scrutinizing experiment to afford a system for practical deduction.

Professors Wheatstone, of London, Steinheil, of Munich, and Jacobi, of St. Petersburgh, appear to have been foremost among those who have endeavored to ascertain the velocity of the electrical current. Its rapidity previous to their labors was supposed incalculable; simple observation had impressed experimenters with the opinion that it was instantaneous; but, like the other imponderable agents, it has not only been shown to be progressive, but also, under peculiar circumstances, of much less celerity than light. It is greatly modified by the incidents connected with different trials. Not only the kind of electricity employed, but the nature and size of the conductor, temperature and electrical tension of the atmosphere, dissimilar means and instruments used by different operators for arriving at results, may perhaps account for the very discordant opinions of practical physicists on this topic. Prof. Wheatstone, making a current of frictional electricity pass along copper wire, and noting the intervals of reflected sparks from a revolving mirror, estimated the speed at 228,000 miles in a second. Our ingenious and distinguished townsman, Mr. Saxton, devised the instrument with which Prof. W. determined these facts. Some truly practical and indefatigable trials have been recently made under the direction of Prof. S. C. Walker, of the United States Coast Survey, which, like the rest, present a heterogeneous mass of probable velocity; taking the whole of them, he deduces the "resultant as 15,890 miles per second, as the most probable value."—(*Silliman's Journal, March*, 1851.)—He used galvanic electricity, and conductors of wire known in trade as No. 9.

Professor Mitchell, of the Cincinnati Observatory, experimented with a sidereal clock on the common telegraphic line, and inferred the velocity at 30,000 miles per second. And again, Messrs. Fizeau and Gounelle, in a paper published in the *Comptes Rendus* of April last, make their result as 111,886 miles per second in copper wire, and 62,159 in iron.—(*Jour. Frank. Ins., Vol.* xx. *p.* 62.)

Here are very many discrepancies, that may be perhaps ascribed to the variable contingencies attending the experiments. Matteucci, Baumgartner, Kirchoff, Ridolphi, and Smauren, are and have been prominent investigators of this subject.

Many trials were made at an early period, on the transmission of galvanism through water and soil. In 1803, experiments were made by F.

H. Basse on the Weser, a distance of 4000 feet being included in the circuit, (*Gilbert's Annalen*, XIV. *p.* 26,) by Erman in the Havel, near Potsdam, (*Gilbert*, XIV. *p.* 385,) and by Aldini at Calais, across about 200 feet of sea water.

Prof. Steinheil, in 1837, first employed the earth as a return portion of the circuit between telegraphic stations, and nearly all the telegraph lines are now arranged on this principle. Much speculation has arisen, as to the mode in which the electrical impulse is conveyed through the earth between the termini; though it is as much under our control as when transmitted through wire conductors, it is difficult to conceive the passage of the fluid in these cases as similar. In all our experiments we find the earth a vast receptacle and source of electricity, and from this fact modern physicists suppose no impulse communicated, but that electricity given to the earth at one end of the line increases the whole amount in it, and the equilibrium is restored by the escape of the redundant fluid into the other extremity of the wire. Baumgartner inferred from experiment, that the geological structure of the intervening earth had some effect upon the time required for the appearance of the electrical impulse at the termini; this, if correct, is strong evidence in favor of conduction of electricity by the earth.

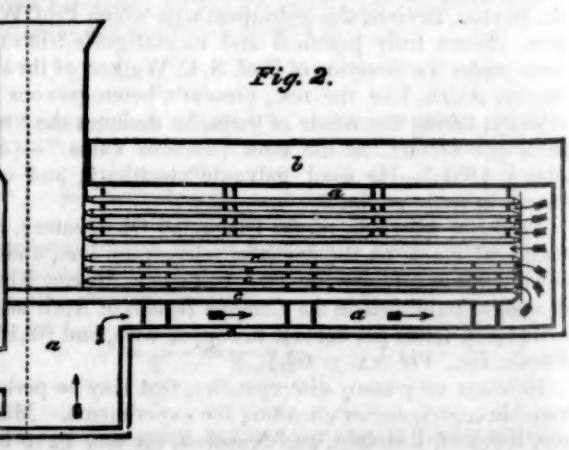
To be Continued.

Description of an Improved Annular Steam Boiler, Patented by THOMAS CHAMPION, *of Philadelphia, Pa., Feb. 18th,* 1851. (*See page* 233.)*

Fig. 1 is an end view, with the outside plate removed to show the ends of the annular cylinders. Fig. 2 is a longitudinal section. The same letters refer to like parts.

Fig. 1.

Fig. 2.



a a represent the fire box, and the arrows in the spaces marked *a*, shows a large fire space nearly surrounding the annular cylinders. The heated air

* Communicated by the Inventor.

and products of combustion are made to return as shown by the arrows at the back and through the spaces between the cylinders, *c c c c*, and pass up the smoke pipe, thus presenting a large heating surface with return spaces, it may be said to get all the benefit of the fuel. There are a number of large evaporation openings communicating with all the cylinders, but *d* is the upper opening above the annular cylinders, to allow the free using of the steam into the steam chamber, *b*, above. The openings spoken of will be observed more particularly in fig. 1, as extending around the cylinders, uniting them together, and answering the four-fold purpose of braces securing the cylinders firmly together, allowing the free ebullition of the water, and passage of the steam upwards into the steam chamber, *b*, and also the settling of dirt and impurities to the bottom part, where they may be blown out by a blow pipe, to keep the boiler free from incrustations. They also expose more fire surface, and thereby tend to more rapid evaporation.

FRANKLIN INSTITUTE.

Proceedings of an Adjourned Meeting, held February 25, 1851.

Algernon S. Roberts, Esq., in the chair.

Isaac B. Garrigues, Recording Secretary.

Mr. G. W. Smith stated that this meeting was held for the purpose of discussing the relative merits of the paddle-wheel and the screw, as instruments for the propulsion of steamers. This evening had been appointed with the expectation that some naval engineers, who were present at the last meeting, would also be present at this, and give the opinions they had formed on this subject, after much practical experience in steamers in actual service. They had, however, been compelled to leave the city. The subject of propellers was comparatively new in this country; such vessels would of course be most proper for canals and narrow streams. Most engineers considered side-wheels the best, but auxiliary screw steamships had increased very much of late. Some had thought the propeller tended to push the vessel into the water under heavy seas, but it would operate as well in that as in smooth seas, while the side-wheel would lift the vessel out, but lost power or speed when the wheels were thrown out of the water by the rolling of the vessel. He would express no opinions on the subject, but would like to hear those of gentlemen present, who were interested in the matter.

Mr. J. H. Towne said that two systems of propelling steam-vessels were prominently before the public at this time, viz.: by paddle-wheels and by screw propellers. The side or paddle-wheel had been in use for a long time, and the most skilful engineers of the world had employed their time and talents for the last thirty or forty years in bringing this system to perfection. The screw, on the other hand, had only recently been introduced into practical operation, and comparatively few mechanical engineers had yet given much attention to it. Most of them

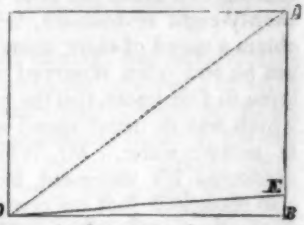
are to this day much prejudiced against this system, and think it will only answer for freighting vessels of slow speed. He (Mr. T.) was of a different opinion; he had taken great pains to obtain information on the subject, and he had had an opportunity of witnessing the performance of the best screw-steamer which had yet been made in this, and perhaps in any country; he alluded, of course, to the Princeton. A careful examination of the whole subject had led him to the belief that the *screw*, as an instrument for propelling *sea steamers*, is better and more efficient than the paddle-wheel—all circumstances considered; and he had no doubt that, for *sea-going vessels*, it would sooner or later supersede the paddle-wheel. The screw has many advantages over the paddle-wheel; it is not affected by the depth of immersion or by the rolling of the vessel, but is equally effective at all depths, and under all circumstances. It admits of the perfect combination of sails and steam, which, for war purposes especially, is of the greatest importance. In a rough sea, the screw being wholly immersed, the resistance is more uniform, and the engines may be worked more steadily and with less danger than with the paddle-wheels, which, being sometimes almost wholly out of water, and at other times deeply immersed, subject the engines to fearful strain. With the screw, light, quick moving engines are required; weighing less, costing less, and occupying less valuable space in the vessel than paddle-wheel machinery, which is more ponderous and costly, and must be placed in the middle and most valuable part of the ship. The cumbrous paddle-boxes, too, are dispensed with, and the resistance they offer in a head wind avoided. Screw steamers, properly constructed, will, therefore, have increased capacity to carry freight or fuel, and be better adapted to make long voyages; they also steer better.

For war purposes screw steamers are especially advantageous; as there are no paddle-boxes, a whole broadside battery may be used; the machinery may be wholly below the water line, beyond the reach of shot; and the vessel may be fully rigged, admitting a perfect combination of sails and steam.

These are some of the advantages of the screw. Another may be claimed, viz.: diminished loss from slip—one evidence of the efficiency of the instrument:—The slip of the Princeton, was less than 10 per cent. Of the Great Britain, during her trial trip, from $9\frac{3}{8}$ to 13 per cent. Of the Liverpool screw, 5 per cent. That of the Dwarf, Mr. Rennie states to be $\frac{1}{8}$ or $\frac{1}{4}$; and the slip of the Arrogant and Encounter, English men-of-war, is stated to be $\frac{1}{8}$ to $\frac{1}{8}$ in smooth water. Mr. T. stated that it was surprising that the slip of the "Great Britain" was so little, because the surface of the propeller bore a very small proportion to the size of the vessel. The propeller of the Princeton, a vessel of less than a fourth the tonnage of the Great Britain, had a propelling surface of 120 square feet, while the surface of the Great Britain's screw was less than 100 feet. He was, therefore, inclined to think that the amount of slip of the Great Britain was much greater than stated. The slip of the best paddle-wheel steamers is from 20 to 27 per cent.

He desired to say a few words about the oblique action of the screw propeller. This is more apparent than real. In considering the action

of the screw, we must not regard the motion of the screw alone, but view it in *connexion with* the onward motion of the vessel. The apparent obliquity disappears almost entirely, and the action of the screw is in fact more direct than the paddle-wheel of small class steamers. This may be illustrated by a very simple diagram. If the advance of the screw in one revolution is from A to B, and there were no slip, the vessel would move through the same distance; the screw would act precisely like a screw in a solid, and there would, of course, be no loss from oblique action.



If, however, as is the case in practice, the vessel advances about $\frac{9}{10}$ of the pitch of the screw each revolution, the obliquity of action would be represented by the line D E, and would vary very little from direct action in a properly made screw.

Mr. T. thought that less power, and, of course, less fuel would be required to produce the same speed with the screw than with a paddle-wheel, other things being equal. In his opinion, a true screw was the best form, as it is as efficient as any other simply as a propeller, and admits of the use of sails alone, as it will, when uncoupled from the engine, turn round with no other resistance than the friction of its shaft bearings and of the water rubbing on its surface. No other form possesses this desirable quality. Captain Erricsson, to whom we are indebted for the practical introduction of the screw as an instrument of propulsion, and who probably understands this subject better than any engineer living, used sections of a true screw. Captain Loper uses a propeller of four blades, having one angle of about 30 deg. at the hub, and 50 deg. at the periphery.

Mr. Towne said that in most cases, screw steamers had been built in as cheap a manner as possible, and very frequently by incompetent persons, wholly ignorant of the principles which should govern them in construction. He might give many examples from his own observation, but it would not be proper to do so for obvious reasons. He regretted for the sake of the system that it had not yet had a fair chance, but he hoped that the day was not very distant, when a fair trial at least would be had. In conclusion he would remark, that it is extremely difficult to get reliable information in relation to the performances of steamers, and that with the exception of the Princeton, he had been compelled to quote from printed accounts, which might not be strictly accurate.

Mr. Smith mentioned the rapid passage of the Glasgow, under steam and wind, as an example of propelling materially aided by sails.

Mr. Bartol remarked, that although in favor of propellers for coastwise and freighting vessels of moderate capacity, when speed was not an object, he thought that there were some objections to propellers that had been overlooked by their friends, and for the purpose of bringing these points before the Meeting, he had solicited letters from several engineers of well-known standing, who had had an opportunity of fully testing their operation and effect under all circumstances. He was in-

formed by Mr. Henry Hunt, a Chief Engineer in the U. S. Navy, and for two years chief engineer of the U. S. Steamer Princeton, that in heavy head winds the slip of the propeller increased very much; that when not making two knots per hour against the wind, the propeller would make twenty-eight revolutions, being the number of revolutions required to obtain a speed of eight knots in smooth water: this was an extreme case, but he had often observed when steaming head to wind, at the rate of three to four knots, that the propeller would make twenty-five revolutions, which was its usual speed when steaming six-and-a-half to seven knots in smooth water. Mr. Whipple, an assistant on board with Mr. Hunt, confirmed his statement, having observed the same result. Mr. Hunt also remarked that the consumption of fuel was as great per revolution at one time as the other. The Princeton was 165 feet long on deck, 30 feet beam, 21 feet 8 inches hold, drawing 19 feet of water, with a propeller 16 feet diameter.

Mr. Bartol had also been informed by Mr. Robert H. Long, assistant engineer, U. S. Navy, and for several months on board the U. S. Steamer Legare, that he had often observed the same result, and that while that vessel was employed on the coast survey, during the summer of 1849, in Chesapeake bay, he had taken particular note of it; and that in calm weather, with the propeller making $31\frac{3}{10}$ revolutions per minute, they could make six knots, but that in heading against a single reefed topsail breeze, they could not make steerage way with the propeller, making 34 revolutions, and a large increased consumption of fuel; that by setting fore and aft sails, and falling off so as to allow them to draw, she would make five knots. The Legare was of iron, 140 feet long, 24 feet beam, 11 feet hold, propeller 9 feet 6 inches in diameter. Both vessels were full powered, having as much boiler as any side-wheel steamer of their tonnage.

Mr. Bartol stated that it was a well known fact, that in side-wheel steamers, the revolutions and consumption of fuel decreased with increased resistance; that the Cunard and Collins steamers made but from four to six revolutions, when steaming against heavy head winds, and were compelled to bank up their fires; that he had examined the log of the U. S. Steamer Mississippi, and found this was uniformly the case.

Mr. Bartol thought that this point had been overlooked, and wished to draw the attention of the Institute to the subject, that it might be properly investigated.

He would also remark, that the difference of cost between side-wheel steamers and propellers, where equal power was used, had been very much over-estimated, as well as the difference of room necessary for the machinery of the two vessels. A side-wheel steamer admits of a more bouyant model, and will give greater capacity to the same tonnage. There was abundant room for both classes of steamers, and the cheap manner in which many classes of propellers may be got up, will cause their rapid introduction; but for Atlantic steamers of the first class, he was not prepared to admit that the propeller could equal the side-wheel in speed, regularity, or economy of fuel.

Mr. Smith inquired what is the diameter of the largest propeller screws?

Mr. Bartol.—That of the Great Britain is 16 feet, the Glasgow 13 feet, the largest side wheels about 36 feet. People exaggerate their horse power of engines in this country; 1000 here would be reckoned but 800 in Great Britain, which arises from a disposition here to make the most of everything on paper.

Mr. Towne said the performance of the Princeton had been entirely satisfactory. He had been on board of her when she attained a speed of thirteen miles per hour through the water, with a slip of less than 10 per cent. The propeller of the Carolina, in his opinion, is not of the best form. He would repeat, that quick moving propeller engines would certainly develop a given amount of power, with less weight and space occupied than would be occupied by slow moving paddle-wheel engines. He thought that the stern of the Princeton was cut away more than was necessary.

Mr. Bartol.—The steamer Jefferson was altered from propeller to side-wheel, and works better under the same circumstances. Steamer Osprey, 500 tons, from Charleston to Philadelphia, averages nine miles per hour.

Mr. Smith inquired if propeller engines worked quicker than others?

Mr. Towne said, that they made more revolutions per minute, but that there was not a great difference in the speed of the pistons.

Mr. Smith spoke of the Royal yacht being the fastest propeller known.

Dr. Turnbull read a description of her, also the Great Britain, from an address of Sir J. Rennie; she was 260 tons burthen, 125 horse power, screw consisting of two blades, making 250 turns in a minute, with a speed of 15¾ miles per hour; the Great Britain is 322 feet long, 3444 tons burthen, 1000 horse power, and screw diameter of 15 feet 9 inches, was sixteen days going from New York to Liverpool.

Mr. Smith inquired the comparative strain of screw machinery upon vessels?

Mr. Grice.—Could not tell; thought if the vessel were light, the propeller might by its revolution have a twirling or racking effect on the hull; if loaded down and with an even keel, no such action would occur; thought them strong as side-wheel steamers—sails will rack vessels as much as steam—propellers may take the lead of side-wheel steamers.

Mr. Smith.—What effect will breaking of propeller shaft have?

Mr. Towne.—Little or no damage will in ordinary cases be done. If the last section of the shaft be uninjured, the propeller will turn while the vessel is under way, without retarding the vessel greatly.

Mr. Tathem. The greatest speed of the Great Britain was 326 miles per day; the Great Western in a hurricane laid too, making ten revolutions per minute, and no speed. Small propellers are used in England, of two blades, 15 feet in diameter; steamers Ohio and Georgia have two paddles, 10 feet long and 16 inch paddle-boards; they make rapid trips.

Mr. Towne said that propellers were steadily gaining ground in England, and that a mail contract for the Cape of Good Hope had been given to a line of screw steamers. There were now 32 British war and 100 mercantile screw steamers in use. He would call the attention of the meeting to the very remarkable performance of a line of five small screw steamers, running from London to Mediterranean ports; they have made

in all 170 voyages outwards and homewards with cargoes, and have run a distance of 190,849 *knots*, at an average speed of 8 to 8½ knots per hour.

There was one steamer of	272	tons and	33	horse power,	average	8	knots.
one "	272	"	30	"	"	8	"
two "	320	"	40	"	"	8½	"
one "	450	"	60	"	"	8½	"

This, considering the small size of the vessels, and making great allowance for *nominal* horse power, is a very remarkable performance, and has perhaps never been equalled by paddle-wheel steamers of the same size and power.

Proceedings of the Stated Monthly Meeting, March 20, 1851.

Professor John C. Cresson, in the chair.

John C. Trautwine, Recording Secretary, *pro tem.*

John F. Frazer, Treasurer.

The minutes of the last meeting were read and approved.

Donations were received from Joseph Fletcher, Esq., of London; Prof. A. D. Bache, Coast Survey; Lieut. M. F. Maurey, U. S. Navy, Washington city, D. C.; Prof. R. S. McCulloh, Princeton, N. J., and Messrs. Charles E. Smith, Peleg B. Savery, Wm. W. Fleming, Dr. L. Turnbull, Dr. G. J. Ziegler, and Prof. J. C. Cresson, of Philadelphia.

The periodicals received in exchange for the Journal of the Institute were laid on the table.

The Treasurer's statement of the receipts and payments for the month of February was read.

The Board of Managers and the Standing Committees reported their minutes.

The following Standing Committees reported their organization, by appointing their chairman, and the times for holding their stated meetings:

On Cabinet of Arts, &c.	John C. Copper, Chairman,	2d Monday	evening.
On Models,	Prosper Martin, "	"	"
Meeting of Institute,	Dr. B. H. Rand, " / Dr. L. Turnbull, Reporter,	"	"
Library,	John Allen, Chairman,	2d Tuesday	"
Cabinet Minerals, &c.	Dr. C. M. Wetherill, "	2d Wednes'y	"
Science and the Arts,	Prof. J. C. Cresson, "	2d Thursday	"
Exhibitions,	Not appointed,	2d Friday	"
Meteorology,	Owen Evans, "	"	"

Candidates for membership in the Institute (8) were proposed, and those proposed at the last meeting (16) were elected members of the Institute.

Dr. L. V. Newton, of New York, presented for the examination of the meeting some specimens of galvanized type, accompanied with examples of printing executed by them, and a letter of recommendation from Mr. W. B. Bodge, manager of the compositors' department of the American Tract Society.

Dr. Newton made the following remarks:—

"This patent is one for covering type, &c., made of the ordinary type metal, or any inferior metal, with a face of some more tenacious and durable one. Hitherto copper only has been used for this purpose, and it is probable that, as it is the most tenacious of all metals, with the exception of iron, and proposes certain other advantages besides, it will never be superseded by any other.

I wish it to be understood, that I do not entirely approve of styling my improvement "*galvanized type.*" The term, whether in point of fact, or as it is commonly understood, does not fully cover all the ground, nor carry all the meaning that the improvement demands. I call it *facing* type anew; and as at present I employ copper for this purpose, I call it *copper facing*. To the new article itself, rather than the mode of producing it, I beg to invite your attention.

It is apparent to those acquainted with the general character of metals, that, other things being equal, copper is greatly superior to any material of which printing types are usually made. The experiments of Guyton Morveau demonstrate that it is near eleven times more tenacious than lead. Both its ductility and malleability are very great, and admirably fit it for this new purpose to which I have applied it. This deduction from its known character, I have already in numerous instances proved true by experiment. There are types on the table that have performed different amounts of work, in situations where a fair comparison could be made between their durability and the durability of common type. The result has been that while the common type could only, at the most, stand at the head line of a* newspaper page, through a single edition of 170,000 copies, the copper-faced passed through six editions of the same number, placed in the same situation, and, as you may perceive, can scarcely be said, even now, to be entirely destroyed.

I have other specimens, which have done less work, and are much less worn. Here are types, which appear to be still in excellent working condition, with the hair lines nearly perfect, that have done twice the quantity of work that common types do in the same position. They have, as all copper-faced type have, a beautiful and highly burnished surface, that shows no disposition to tarnish in the open air. This circumstance is another advantage my type possesses. It requires less ink on the rollers and less on the face of the type, to give a fair and distinct impression; there should, therefore, be less ink wasted, and if the presswork be equal, the printing will look better. I have copies of the New York Courier and Enquirer, the Boston Daily Journal, several large sized weeklies, both of Boston and New York, as well as several quarterly and monthly publications, all of which are printed on my copper-faced type. Their appearance will speak for the beauty of the work. I have also a specimen of the most beautiful job printing, done with nearly the finest kind of type in use. Nothing can be more perfect than this. It may, I believe, be fairly assumed, that copper presents a better working face than almost any other metal.

In answer to the inquiry of a member respecting the expense of copper-

* American Messenger, published in New York, by the American Tract Society.

faced type, I reply that it exceeds that of the common type only about 30 per cent.

It was inquired how the two metals might be separated when worn out, so that the old type metal might be employed again. The answer is, that there is no difficulty, as lead fuses at about 500 degrees, and copper at about 1800, so that as soon as the lead becomes fluid, the copper will go to the bottom unaffected by the heat.

Will there not be constant galvanic action between the copper and lead? No, I believe not, because all the conditions for causing electric excitement are not present. There can be no electric action without a fluid to produce chemical changes. When, however, the types are moist, it is probable that at the visible point of contact between the two metals, a certain amount of electrical disturbances may ensue. But inasmuch as the action is wholly at the lines where the two metals join, and not between them, such an action can never have the effect to loosen them from each other. The oxidizement of lead being exterior, will produce no sort of inconvenience; while the copper, thus excited negatively, will repel oxygen, and always remain bright. This effect, I think, I have observed repeatedly. At first I was astonished on seeing the copper maintain a brilliant surface, after it had been used, when, as it appeared to me, it should have been foul or tarnished. On reflection, I concluded it was attributable to this single circumstance of external electric action. As touching types made wholly of copper, that have been spoken of, it will be perceived at once, by applying this fact, that they must necessarily be greatly inferior to the compound type. White moisture would soon so injure the body of the single metal type by rapid oxidation, that it could not be "justified" in lines, and could hardly, if at all, be set up by the compositor, the copper-faced would be quite free from both these objections. Types made altogether of copper, never can be used successfully against my type, for the reasons that I have just assigned, to which may be added their much greater original cost. I may add, that printers, generally, prefer the copper-faced to the common type for working on, because, as they say, they can distinguish the face more readily, and therefore can set it up faster."

Mr. Prosper Martin then called the attention of the meeting to specimens of a compound of iron and copper, which he had promised at the last meeting, and made some observations relative to the melting point of different kinds of iron; he stated those given by Wedgewood, and proposed immersion of the heated metal in water, so as to ascertain the amount of specific heat when in that state.

Dr. Hare considered this method as worthy of attention.

Professor Frazer remarked that, from some experiments which he had made with the thermo multiplier, he thought that we were more likely to obtain satisfactory results from it. The instrument had been used for this purpose by several experimenters.

Mr. Bartol stated that he had made some inquiry in relation to the shaft of the steamer Atlantic, and found that it was forged entirely of Salsbury iron, which has generally been considered the best in the country, and is used by the Navy Department for chain cables. The shaft turned

up in the lathe very handsomely, and was considered very superior iron. The break was in the journal extending diagonally out under the eccentrics, and the fracture shows a perfectly sound shaft, but the grain of the iron is unusually large, having undergone a complete change from the time it was received in the bar. The exterior of the shaft was very soft, and it had frequently been found necessary to keep a stream of water running on the journals of the shafts of this steamer. Mr. B stated that he was informed by those who forged the shaft, that they found that the tendency of Salisbury iron, when worked into large masses, was to crystallize to a much greater extent than any other iron used by them. At present they prefer the iron made for them by Mr. Peter Cooper, at Trenton, N. J.

Mr. G. W. Smith exhibited some beautiful variegated English tiles, the manufacture of Messrs. Minturn & Co. Their durability was superior to marble, as in many of the edifices of Europe tiles had been trod upon for nearly a thousand years, and remained almost unworn. They were formed of finely powdered, colored, argilacious and siliceous matter, subjected to a pressure of some 60,000 pounds, and then baked to give permanent shape. The ancients arranged their mosaics in separate rhombs or squares, which, to be well seen, as for instance those in the Vatican, it was necessary that the observer should stand at some distance above them. Their antiquity was great, as tiles are found in the ruins of Babylon. Some of them had been used in a few churches of this city. Several elegant designs for them on paper were shown. He afterwards introduced an English carpet and rug, in which the design was attached by a medium of gum elastic, that rendered it useful in the prevention of moisture from the floor, and added to the durability and elasticity of the carpet.

Dr. Hare submitted to the attention of the meeting, an apparatus for ascertaining whether the phenomena attending the attrition of pieces of quartz, when rubbed briskly together, had any thing in common with those ascribed by Schonbien, to a supposed new halogen body, named by him ozone, and made the following remarks. The odor which results from electrical excitement, or discharges between oppositely electrified bodies, had long been familiar to electricians. This odor is of a nature to recall that of phosporus to all acquainted with the smell which this substance has when slowly oxydizing in the air, while to those, unacquainted with the odor of oxydizing phosporus, the universally known odor of burning sulphur has been cited as an exemplification. Hence, the often repeated allegation of a sulphurous smell being consequent to the passage of lightning. A similar property was likewise observed in oxygen, which had been extricated from water by electrolysis. I observed a like odor about twenty-five years ago, when a large tube, used for the inflamation of explosive mixtures of hydrogen and atmospheric air, was burst by the process; as well as upon other occasions, when similar results ensued.

Schonbien, who has attained much celebrity as the inventor of gun cotton, was the first to associate phenomena of the kind alluded to, under one view; and to show that the air which had acquired the odoriferous property in question, however obtained, had certain chemical properties in common. These properties were analogous to those displayed by

chlorine, bromine, iodine, fluorine, and cyanogen, which constitute the halogen class of Berzelius; and hence the distinguished investigator conceived that they might be due to some body of that class, which had escaped detection.

To this supposed body he gave the name of "ozone," from Greek words which signify the production of odor.

As cyanogen is known to consist of two atoms of carbon and one of cyanogen, it would not, *a priori*, to be unreasonable that another body should be formed deserving to be ranked in the same class.

Latterly, Schonbien has advanced the idea that ozonification may be owing to a combination consisting of peroxide of hydrogen and bioxide of nitrogen, or in other words, of oxygenated water and nitric oxide. But this inference seems to have been invalidated by an experiment made by De la Rive and Marignac. These distinguished chemists ozonized oxygen by putting electric sparks through the gas, while exclusively occupying a tube in which it had been evolved from chlorate of potassa previously fused, and consequently devoid of moisture.

Hence Berzelius, and other distinguished chemists, deemed it reasonable to ascribe the phenomena to a peculiar state of oxygen.

It had long been known that certain elements were capable of very different states; as, for instance, carbon in the forms of tinder, charcoal, anthracite, plumbago, and the diamond.

According to Professor Draper, chlorine after exposure to the solar rays, becomes more capable of combining with hydrogen under a feeble illumination.

This diversity is displayed in many instances by bodies in what has been called their nascent state, which exists just as they escape from combination. Under these circumstances, they will combine with elements for which, usually, they display no affinity. Thus nitrogen, as it exists in the atmosphere, shows no affinity either for carbon or hydrogen, yet when nascent, forms with hydrogen, ammonia, with carbon, cyanogen. On this account I have concurred in opinion with Berzelius, that the phenomena ascribed to ozone may be caused by oxygen in a peculiar state.

It is requisite to mention, that among the tests of the presence of ozonized air, the mixture of starch paste with a solution of iodide of potassium is the most delicate. This is dependent upon an inexplicable but well known property of starch to be rendered blue by a very minute portion of free iodine. A very small addition of chlorine, by seizing an equivalent portion of potassium, liberates enough iodine to produce blueness in the mixture; and, in like manner, a very small proportion of ozonized air, whatever may be its source, renders starch blue by a like procedure.

In like manner, by exposure to ozonized air, strips of paper, drenched with a tincture of gum guiacum, are rendered blue, as these changes would have resulted from the presence of chlorine, and as neither that nor any other of the known halogen bodies could be present, the agency of some undetected body of that class was reasonably to be inferred.

Having given this preliminary brief sketch of the state of our know-

ledge respecting ozone, it is time to proceed to explain its connection with the contrivance of the apparatus before the assemblage.

It had occurred to me that the smell and corruscations arising from the attrition of quartzose masses, briskly rubbed against each other, might be due to the same cause, analogous, if not identical, with that to which the phenomena of ozone are indebted for their existence.

Nothing could be more unaccountable than this odor. That it cannot be due to any organic matter entering into the composition of the quartz must be evident; in the first place, because the smell is produced by the purest and most transparent specimens of rock crystal in the regular form, and in the second place, because ignition to bright redness does not destroy nor even diminish the property.

One thousand grains of cellular horn stone, or French burr, on ignition as above stated, lost five grains—that is to say, ½ per cent. of its weight, without, however, losing the property of producing light and smell.

It occured to me that it might help to remove the mystery, were an apparatus constructed by which the attrition of quartzose masses might be made more efficaciously than could be effected by an operator unaided by mechanism. Having suggested this idea to my friend, Prof. Henry, he said that I might have such an apparatus constructed at the expense of the Smithsonian Institution. The apparatus, which is before the meeting, was made accordingly.

Two pigmy mill-stones, of seven inches, made of cellular horn stone, known vulgarly as French burr, and resembling those used in grist mills, were procured and supported as in the usual way, one above the other; excepting that the upper one hangs by means of a bolt upon a spiral spring of brass wire, sustained by a cross of iron, resting upon screw nuts, upheld by four iron rods, each inserted at its lower end in a circular plate of cast iron, so as to be equidistant from each other. The surface of the iron plate is turned true, so as to enable it to serve as an air-pump plate. It rests upon four columns, which elevate it from a base board sufficiently to admit of a pulley band and larger wheel to work in a parallel plane below that in which the plate is situated. There is also room for a lever, from which a stirrup hangs as a support for the spindle of the pulley, on the apex of which plane extended upwards through a perforation in the axis of the plate, the lower mill-stone rests. This spindle passes through a stuffing box, so as to be air-tight; the stirrup allowing it to retain its perpendicularity, notwithstanding the curvilinear movement of the lever when employed to raise or lower the stone.

The nuts upon which the cross supporting the upper stone has been mentioned as resting, are so used as to render the lower surface of the stone horizontal, while, as it hangs upon a bolt which occupies the axis of the spiral spring, the pressure on the lower stone, when brought into contact with it, may be made as gentle as necessary. The lower stone being balanced on the point of the spindle, is made to turn with it by means of a pin proceeding from its lower surface and another proceeding from the spindle, which operate as a carryer in a lathe.

In order to put the apparatus in operation, the lower stone is made to revolve by means of the pulley, band, and wheel; while, by means of the lever, the stone is so raised as to produce sufficient contact with that sus-

pended above it. Under these circumstances, scintillation and the odor which is the object of inquiry resulted. In no way, however, could I produce the chemical effects of ozone upon iodized starch or tincture guiacum. On directing a jet of hydrogen between the stones, it took fire forthwith; but I could not, by means of a gold leaf electrometer, detect any electricity. When the upper stone was removed, and a piece of an old file of a large size made to scrape over the surface of the lower stone, a conducting connexion between the file and an electrometer was productive of no electrical indication.

The plate being ground to fit a large receiver, the stones were in successive experiments made to revolve in vacuo, in hydrogen, and in a vacuity previously replete with this gas, without any dimunition of the luminous phenomena. These, it seems from the inflammation of the jet of hydrogen, constitute a simple case of ignition. During the collision of flint with steel, a portion of the metal being struck off, takes fire, and thus is enabled to convey ignition to tinder or spunk. The incapacity of two pieces of quartz to produce fire in like manner, arises from the incombustability of the particles struck off from them, which consequently cool before they meet any mass with which they are not in contact at the moment when the ignition supervenes.

As the burr stones are opaque, the light is much less advantageously seen when they are both employed, than when the upper one is replaced by a comparatively small mass of transparent quartz. The concentration of the frictional force, and the transparency of the mass under which the ignition is effected, makes the corruscations very brilliant in a room otherwise darkened.

So great is the resistance of the surfaces of the stones when brought into revolutionary collision, that the maximum effect which they are capable of producing, would require more force than can be communicated by the human power, through a single hand actuating the stones by means of a wheel, pulley, and band.

Of course cog wheels might be resorted to, and the power of steam or that of Professor Page's electro-magnetic machine, employed to obtain a greater effect. I have lately been informed, that in English potteries where flint is employed as an ingredient in the ware manufactured, the grinding of this material is productive of an intolerable fœtidity. In an atmosphere thus imbued with fœtidity, chemical effects ought to be observable if there be any connexion between the source of this fœtidity and that produced by ozonizing agents.

It is long since it occurred to me, that the phenomena of light, under all the various hues which it is capable of producing, are ascribed to the undulatory affections of an ether pervading the universe; so the still greater variety of odors which influence our olfactory nerves, may be due to vibratory agitation of the same medium. *

Consistently it may be conceived that the odor produced during ozonification, during the attrition of quartz, is due to an odoriferous etherial agitation.

* If odors are to be ascribed to etherial affections produced by impulses proceeding from odoriforous substances, consistently tastes must have an analogous origin, and mesmeric influence, so far as its existence has been proved, seems equally to require etherial intervention.

Mr. Agnus N. Macpherson made the following remarks on the manner of making steamboat shafts, which he illustrated by models:—

The present method of faggoting steamboat shafts, is to take a large bar of round iron, termed a "poster staff;" the use of which is to introduce the iron into the furnace, and prepare the end by flattening, to receive a series of faggoting billets, which are square-shaped pieces of iron, measuring about four or five inches on the side, and four or five feet long.

These billets are then piled upon the poster staff, until a sufficient number have been laid together to measure the required size.

The mass is then introduced into the furnace, and retained there until a sufficient degree of heat is imparted to it to weld, when it is submitted to the action of the hammer, and a portion of the required work completed.

The end of the piece is again flattened, and a similar process of piling, heating, and hammering is followed until the required length and shape is obtained.

This method is the most expeditious and cheapest that could be adopted. It is, however, objectionable in one respect, there is a great difficulty experienced by the workmen in the matter of making a sound weld between the piece of shafting already made, and the ends of the piles which have been added. This unsoundness would describe a diagonal line across the shaft, and is probably one of the chief causes of fractures in steamboat shafts being almost always of a diagonal shape.

There are two causes operating to produce this unsoundness, one is, the heat of the furnace is much more readily imbibed by the pile of loose faggots than by the solid portion of the shaft already made, causing a very great difference in the relative degree of heat contained in the two portions of the mass. The other is, that the part already spoken of, (the end of the piles) is necessarily placed near the furnace mouth, where it not only has less chance of heating equally, but the heat it does receive, is partly extracted by evaporation from without.

I would propose as a remedy for this, first, that the faggoting billets be first placed in the furnace by themselves in separate portions, and heated, and hammered into slabs of the required size, with one end scarfed down for welding. Second, that the end of the piece of work already made, should be left the full size. One of these slabs should then be placed on the end of the piece, in the same position as the billets in the first mentioned method, and then submitted to the action of the furnace and hammer, and the process repeated until the work was completed.

It is obvious that, by this method, a sounder and better piece of work could be produced. The two portions required to be welded, being nearly of equal size, would imbibe heat uniformly. The scarf on the piece which had been added, being small and light, would be readily welded, and the two portions would draw equally into the required shape; and if, from any cause, such as an insufficient heat, or a lodgement of scoria, an unsoundness did exist, the line of such unsoundness would be in a parallel directien with the shaft, which would, therefore, not be so liable to fail in the performance of its required duty, nor to wring asunder by the torsion to which it is constantly subjected.